The world's most comprehensive encyclopedia of the military weapons of the 20th century

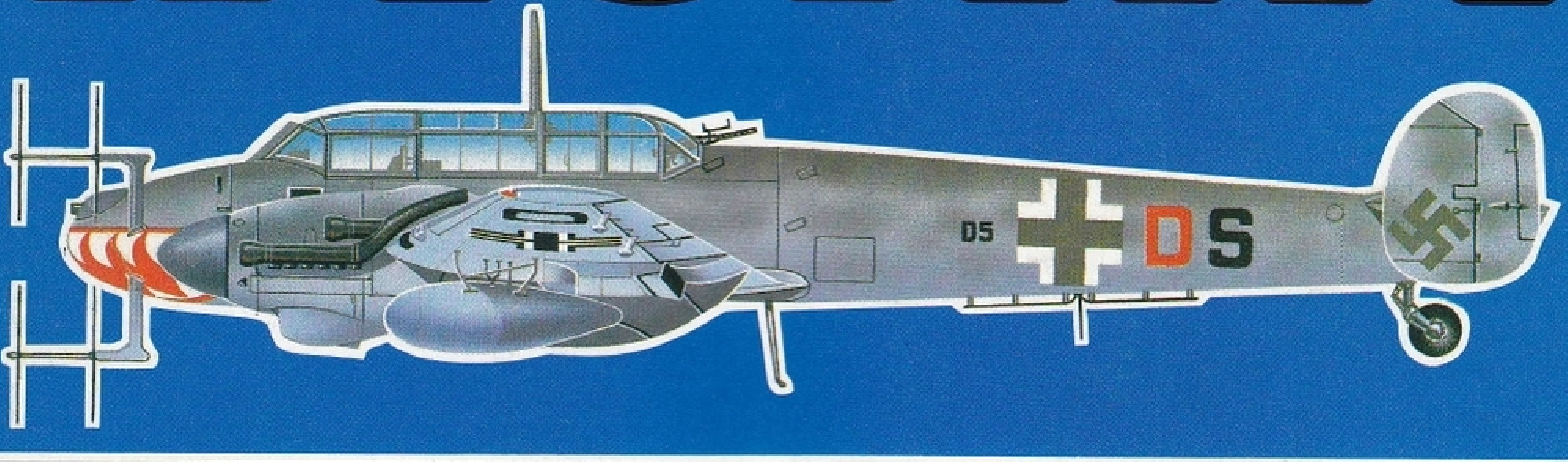
WAR MACHINE

An ORBIS Publication

80p

37

IR £1 Aus $1.95 NZ $2.25 SA R1.95 Sing $4.50 USA & Can $1.95



Armed Forces of the World: US Navy (Part 4)

Junkers Ju 88 in Action

The German *Nachtexperten*

The Helmore Turbinlite Experiment

A fully illustrated guide to Night Fighters of World War II

WAR MACHINE

Volume 4 **Issue 37**

CONTENTS

Night Fighters of World War II

Bristol Blenheim Mk IF 722
Bristol Beaufighter 722
Boulton Paul Defiant 723
de Havilland Mosquito 724
Hawker Hurricane Mk II 724
Dornier Do 17, Do 215 and Do 217 725
The German *Nachtexperten* 726
Heinkel He 219 Uhu 728
Junkers Ju 88 728
Junkers Ju 88 in Action 729
Focke-Wulf Fw 190A 734
Messerschmitt Bf 110 734
Messerschmitt Me 262B-1a/U1 735
Douglas P-70 Havoc 736
The Helmore Turbinlite Experiment 737
Northrop P-61 Black Widow 738
Kawasaki Ki-45 Toryu 739
Nakajima J1N1-S Gekko 739
Potez 631 740

Armed Forces of the World

US Navy (Part 4) iii

Published by
Orbis Publishing Ltd

© Aerospace Publishing Ltd 1984
Colour profiles, diagrams and cutaway drawings © Pilot Press Ltd

Editorial Offices
War Machine
Aerospace Publishing Ltd
10 Barley Mow Passage
London W4 4PH

Managing Editor: Stan Morse

Editorial: Trisha Palmer
Chris Bishop
Jon Lake
Chris Chant
Design: Rod Teasdale
Colour Origination: Imago Publishing Ltd, Thame, Oxon
Typesetting: SX Composing Ltd
Film work: Precise Litho Ltd
Artists:
Keith Fretwell
Keith Woodcock
Authors: Francis K. Mason, Bill Gunston

Consultant Editor: Major General Sir Jeremy Moore KCB OBE MC, Commander of British Land Forces during the Falklands campaign.

17845

Printed in Great Britain by The Artisan Press Ltd

Distribution and marketing offices:
Orbis Publishing Ltd
Orbis House
20-22 Bedfordbury
London WC2N 4BT
Telephone: 01-379 6711
Circulation Director: David Breed
Marketing Director: Michael Joyce

WAR MACHINE
Price UK 80p. IR £1. Aus $1.95. NZ $2.25. SA R1.95. Singapore $4.50. USA and Canada $1.95

How to obtain your copies of WAR MACHINE: Copies are obtainable by placing a regular order at your Newsagent, or by taking out a subscription.

Subscription Rates
For six months (26 issues) £23.80; for one year (52 issues) £47.60. Send your order and remittance to Punch Subscription Services, Watling Street, Bletchley, Milton Keynes, Bucks MK2 2BW, being sure to state the number of the first issue required.

Back Numbers
UK & Eire: Back numbers are obtainable from your Newsagent or from WAR MACHINE Back Numbers, Orbis Publishing Limited, 20-22 Bedfordbury, London WC2N 4BT at cover price.
Australia: Back numbers are obtainable from WAR MACHINE Back Numbers, Gordon & Gotch (Aus) Ltd, 114 William Street, PO Box 767G, Melbourne, Vic 3001.
South Africa, Europe, Malta and New Zealand: Back numbers are available at cover price from your Newsagent. In case of difficulty write to the address in your country given for binders. South African readers should add sales tax.

How to obtain binders for WAR MACHINE

UK & Eire: Send a cheque or Postal Order for £3.95 per binder (incl p & p) payable to Orbis Publishing Ltd to WAR MACHINE Binders, Orbis House, 20-22 Bedfordbury, London WC2N 4BT
Europe: Write with remittance of £5.00 per binder (incl p & p) payable to Orbis Publishing Ltd to WAR MACHINE Binders, Orbis House, 20-22 Bedfordbury, London WC2N 4BT.
Malta: Binders are obtainable through your local Newsagent, price £3.95. In case of difficulty write to WAR MACHINE Binders, Miller (Malta) Ltd, M.A. Vassalli Street, Valletta, Malta.
Australia: For details of how to obtain your binders see inserts in early issues or write to WAR MACHINE Binders, First Post Pty Ltd, 23 Chandos Street, St Leonards, NSW 2065. The binders supplied are those illustrated in the magazine.
New Zealand: Binders are available through your local Newsagent or from WAR MACHINE Binders, Gordon & Gotch (NZ) Ltd, PO Box 1594, Wellington.
South Africa: Binders are available through any branch of Central News Agency. In case of difficulty write to WAR MACHINE Binders, Intermag, PO Box 57394, Springfield 2137.

Note: Binders and Back Numbers are obtainable subject to availability of stocks. Whilst every attempt is made to keep the price of the issues and binders constant, the publishers reserve the right to increase the stated prices at any time when circumstances dictate. Binders depicted in this publication are those produced for the **UK market only** and may not necessarily be identical to binders produced for sale outside the UK. Binders and issues may be subject to import duty and /or local taxes, which are not included in the above prices unless stated.

The WAR MACHINE published by Orbis Publishing Ltd has no connection with the WAR MACHINE published by Emjay. The latter is a magazine devoted to computer simulation gaming and further information and subscription details can be obtained from Emjay, 17 Langbank Avenue, Rise Park, Nottingham NG5 5BU, England.

Picture acknowledgements

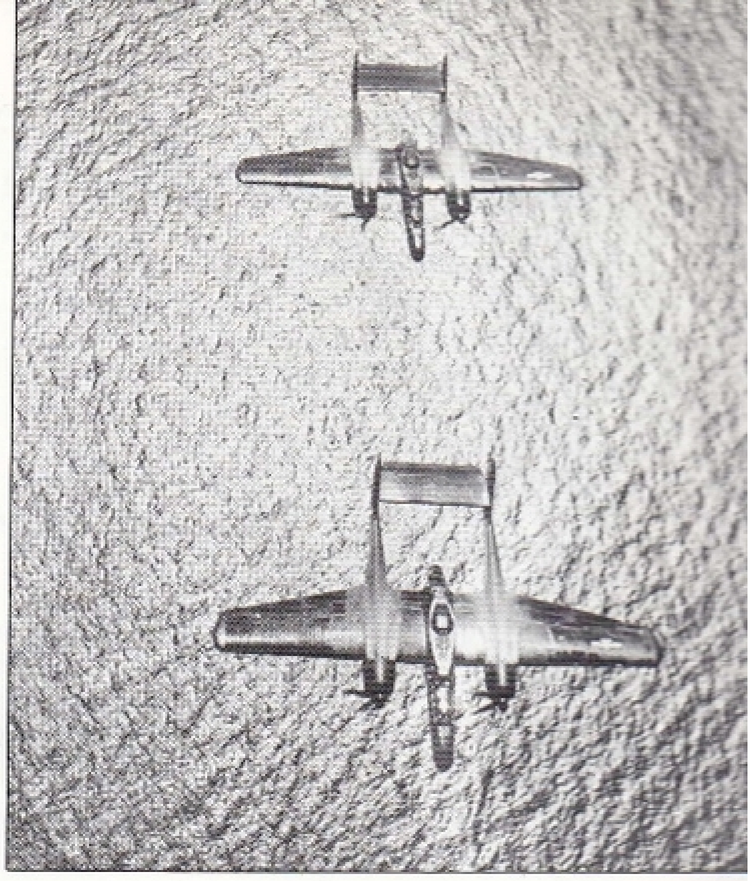
Cover photograph: Charles E. Brown-RAF Museum of Aerospace **721:** US Air Force. **722:** Imperial War Museum. **723:** Imperial War Museum. **724:** Imperial War Museum/Charles E. Brown-RAF Museum of Aerospace. **738:** US Air Force/US Air Force. **(iii):** US Navy/US Navy. **(iv):** US Navy/US Navy.

WAR MACHINE

Forthcoming issues feature:
Modern Destroyers
Flying-boats of World War II
Modern Self-propelled AA Guns
Light Bombers of World War II
Modern Towed Artillery

Night Fighters of World War II

World War II saw the development of night fighting from a very imprecise, hit-or-miss art using rudimentary equipment in hastily converted aircraft to a refined science using highly-developed tactics in purpose-built aircraft equipped with sophisticated radar and weapons.



Two Northrop P-61 Black Widows sweep over the Pacific near Saipan, in the Marianas Islands, late in January 1945. The Black Widow enjoyed particular success as a night fighter in the Pacific, where its long range and firepower could be effectively used.

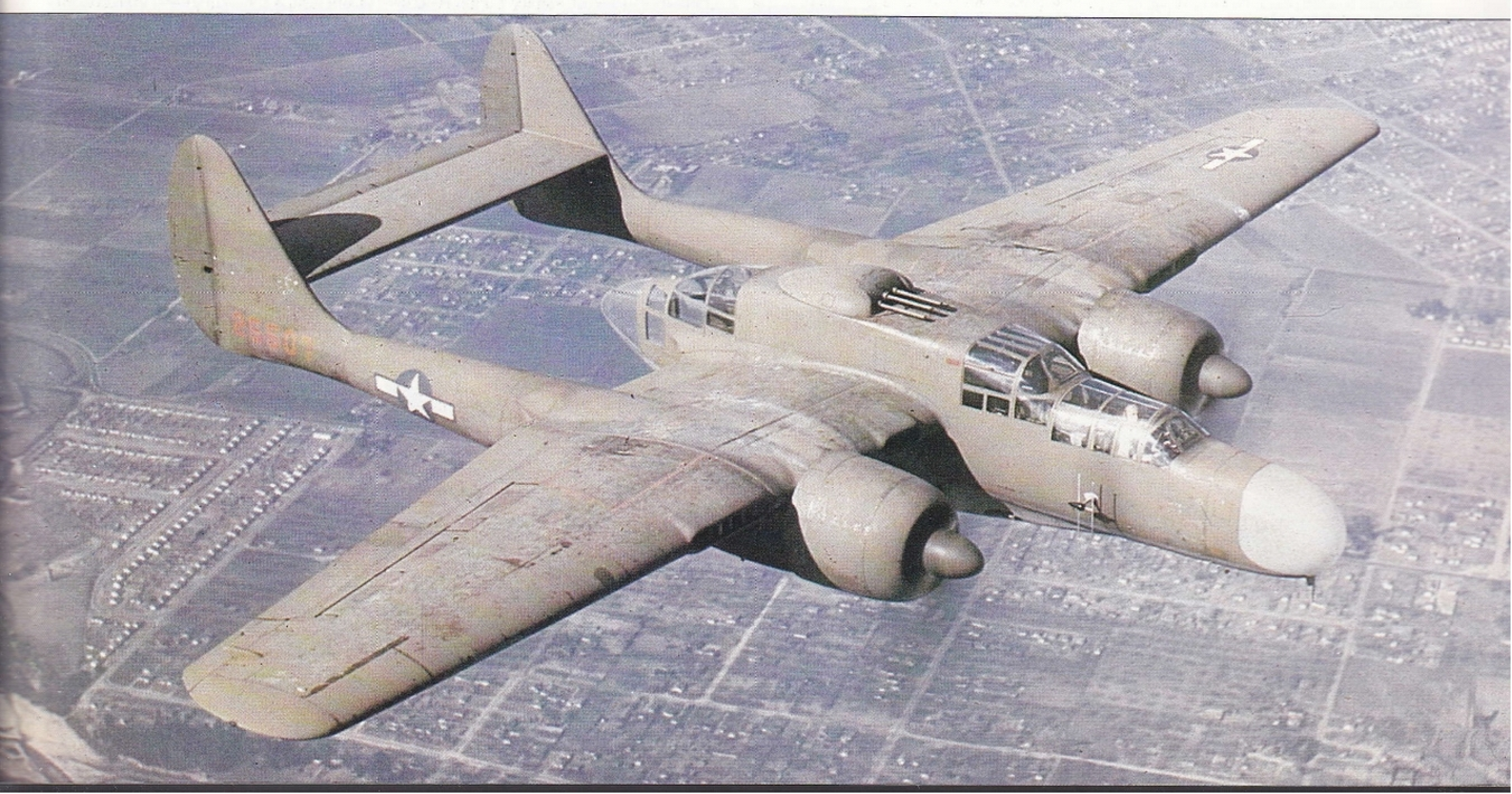
When World War II started in September 1939 no air force was equipped with aircraft specifically designed for the night fighting role. Only the UK had woken up to the fact that, with the raison d'etre of the modern air force being offensive bombing operations, such aircraft would be urgently needed; most air forces made do using night flying day fighters, in conjunction with ground searchlights. While the RAF was conducting experiments with rudimentary airborne radar in a handful of obsolescent Bristol Blenheims, the Bristol aircraft company was hard at work developing the Bristol Beaufighter, the world's first dedicated night-fighter to carry radar, produced entirely on their own initiative. This entered service during the Battle of Britain and first saw combat in the German night *Blitz* of 1940-1.

From these small beginnings began an entirely new science of aircraft interception that has continued to advance ever since, the science of locating the enemy on ground radar, guiding the fighter towards its target by means of ground controllers and, eventually, using airborne radar, closing to within range of the fighter's own weapons for the kill. Although more within the scope of the bombers' operations, the night-fighter crews had to contend with a growing, parallel science of countermeasures, as the bomber's equipment began to include the means to blind the ground radar and to provide warning of the approach of a night-fighter.

Although the British advanced relatively quickly with successively improved Beaufighters and de Havilland Mosquitoes (as well as discarding the outmoded Blenheims, Boulton Paul Defiants and Hawker Hurricanes), and unquestionably led the world in night-fighting techniques and technology (until the arrival in service of the American-developed centimetric AI Mk X), German ingenuity produced highly efficient night-fighter adaptations of the Messerschmitt Bf 110 and Junkers Ju 88; these two aircraft, together with the excellent Heinkel He 219, provided the backbone of the Reich's night-fighter defence between 1942 and 1945. Not surprisingly, with so many RAF heavy bombers operating almost nightly over Europe during this period, there came onto the scene numerous Luftwaffe night-fighter pilots whose individual victory scores far eclipsed any achievements of their Allied counterparts, it being fairly commonplace for German pilots to destroy four or more Avro Lancasters and Handley Page Halifaxes on single sorties; once they had entered the great bomber stream their victory bag was limited only by their use of ammunition and fuel. Moreover, the development of the upward-firing cannon (not to mention fairly efficient airborne radar) enabled the Germans to destroy RAF bombers in such a way that the British 'didn't know what had hit them'.

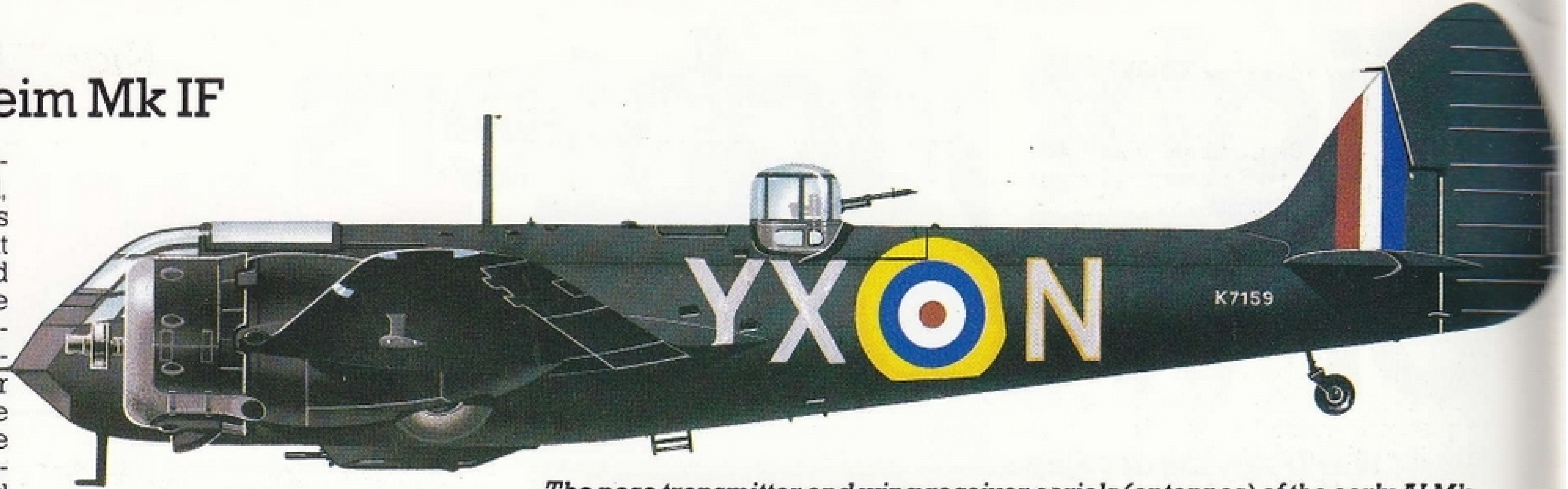
Elsewhere, with concerted night operations conducted on a much lesser scale until the onset of the great American night offensive against Japan in 1944, night fighting demanded less attention to sophisticated equipment and tactics than in Europe, although these were quickly introduced when the Boeing B-29 started operations. By and large, during the first two years of the Pacific War, neither Japan nor the United States engaged in significant night bombing, and accordingly did little until 1943 to introduce specialist night-fighters, the Douglas P-70 (though widely employed) being unequivocally a makeshift adaptation of a light bomber.

Of all night fighters of World War II, the Northrop P-61 Black Widow was the most carefully planned from the outset for this challenging task. It had radar, a pilot, two gunners and devastating firepower.



UK

Bristol Blenheim Mk IF



The nose transmitter and wing receiver aerials (antennas) of the early AI Mk III radar can be seen on this Blenheim Mk IF, which in 1941 was training crews at No. 54 Operational Training Unit, RAF.

The **Bristol Blenheim** entered RAF service as a light bomber in 1937 and, despite great hopes for the type, it was becoming outmoded from the day it arrived, being under-armed and therefore capable of carrying no more than a puny bombload by later standards. It was a neat and compact design, however, and lent itself to further development as a bomber, the Blenheim Mk IV with lengthened nose joining the RAF in 1939. In the realization that the Blenheim Mk I would quickly be superseded, plans were put in hand to introduce it as a night-fighter for service with Fighter Command, and in December 1938 four squadrons (Nos 23, 25, 29 and 64) started taking deliveries. Most of these early aircraft were ex-Bomber Command aircraft with sealed bomb doors and bomb gear removed; their armament remained a single fixed forward-firing 7.7-mm (0.303-in) Browning gun and a Vickers 'K' gas-operated gun of the same calibre in the dorsal turret. These four regular squadrons, together with Nos 600, 601 and 604 of the Auxiliary Air Force (re-equipped in the following month) were employed principally to work up and calibrate the new CH coastal radar chain being built at top speed along the UK's south and east coasts. Early in 1939, however, there became available the first of 200 gun packs, each containing four Browning guns and manufactured by the Southern Railway's depot at Ashford, Kent, and by the outbreak of war in September 1939 most converted Blenheim Mk I (now termed **Blenheim Mk IF**) aircraft had been modified to have such a pack fitted under the fuselage nose. Meanwhile one flight from No. 25 Squadron had had its Blenheims modified with the first 'breadboard' examples of airborne interception radar, and these were undergoing faltering trials over the Thames Estuary in collaboration with the Bawdsey Manor CH coastal radar when war broke out. In due course this radar was standardized to become AI Mk III and was fitted in about two dozen Blenheims, most of the remainder being flown by the Fighter Interception Unit (FIU). Several other Blenheim night-fighter squadrons (among them Nos 68, 145, 219 and 222) were formed, but they were mostly short-lived. At the time of the Battle of Britain night-fighter Blenheims soldiered on in search of the small numbers of German night raiders, and on 21/22 July 1940 an aircraft of the FIU made history when it became the first employing AI radar to destroy an enemy raider (a Dornier Do 17) at night. Possessing very pedestrian capabilities, the Blenheim could scarcely catch any of the modern aircraft of 1940 and, although it achieved further victories during the German night *Blitz* of 1940-1 (indeed, formed the backbone of the UK's night defence), it was gradually phased out of service with the arrival of the powerful Bristol Beaufighter.

Specification

Blenheim Mk IF

Type: three-seat night-fighter

Powerplant: two 840-hp (626-kW) Bristol Mercury VIII nine-cylinder air-cooled radial piston engines

Performance: maximum speed 418 km/h (260 mph) at 4265 m (14,000 ft); initial climb rate 488 m (1,600 ft) per minute; service ceiling 8230 m (27,000 ft); normal range 1770 km (1,100 miles)

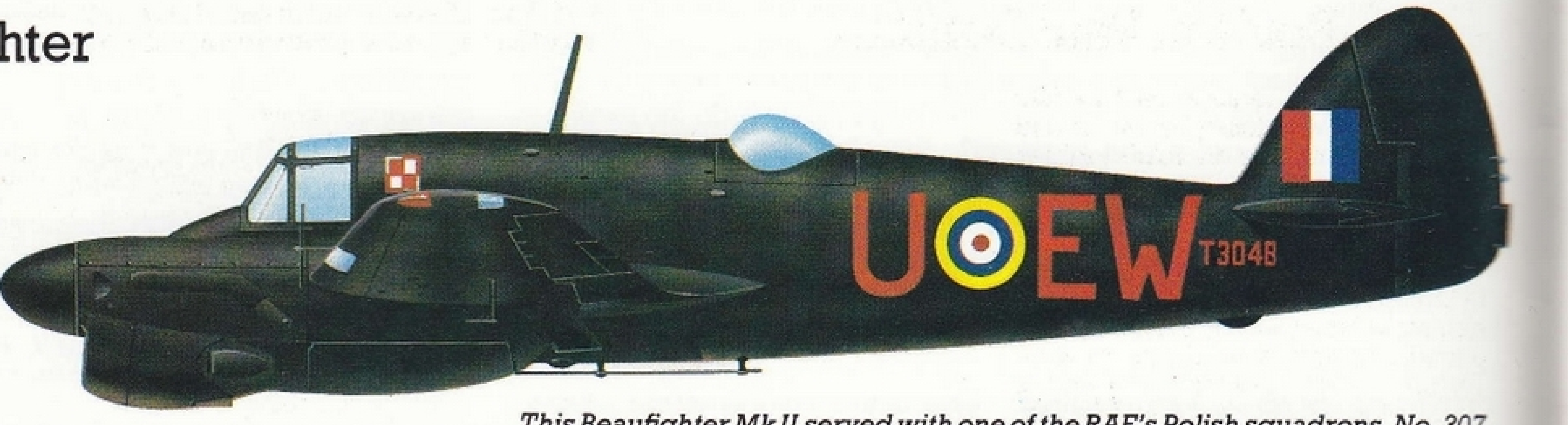
Weights: empty 3651 kg (8,050 lb); maximum take-off 5489 kg (12,100 lb)

Dimensions: span 17.17 m (56 ft 4 in); length 12.45 m (40 ft 10 in); height 3.00 m (9 ft 10 in); wing area 43.57 m^2 (469 sq ft)

Armament: four 7.7-mm (0.303-in) machine-guns in ventral tray firing forward, and one 7.7-mm (0.303-in) machine-gun in dorsal turret

UK

Bristol Beaufighter

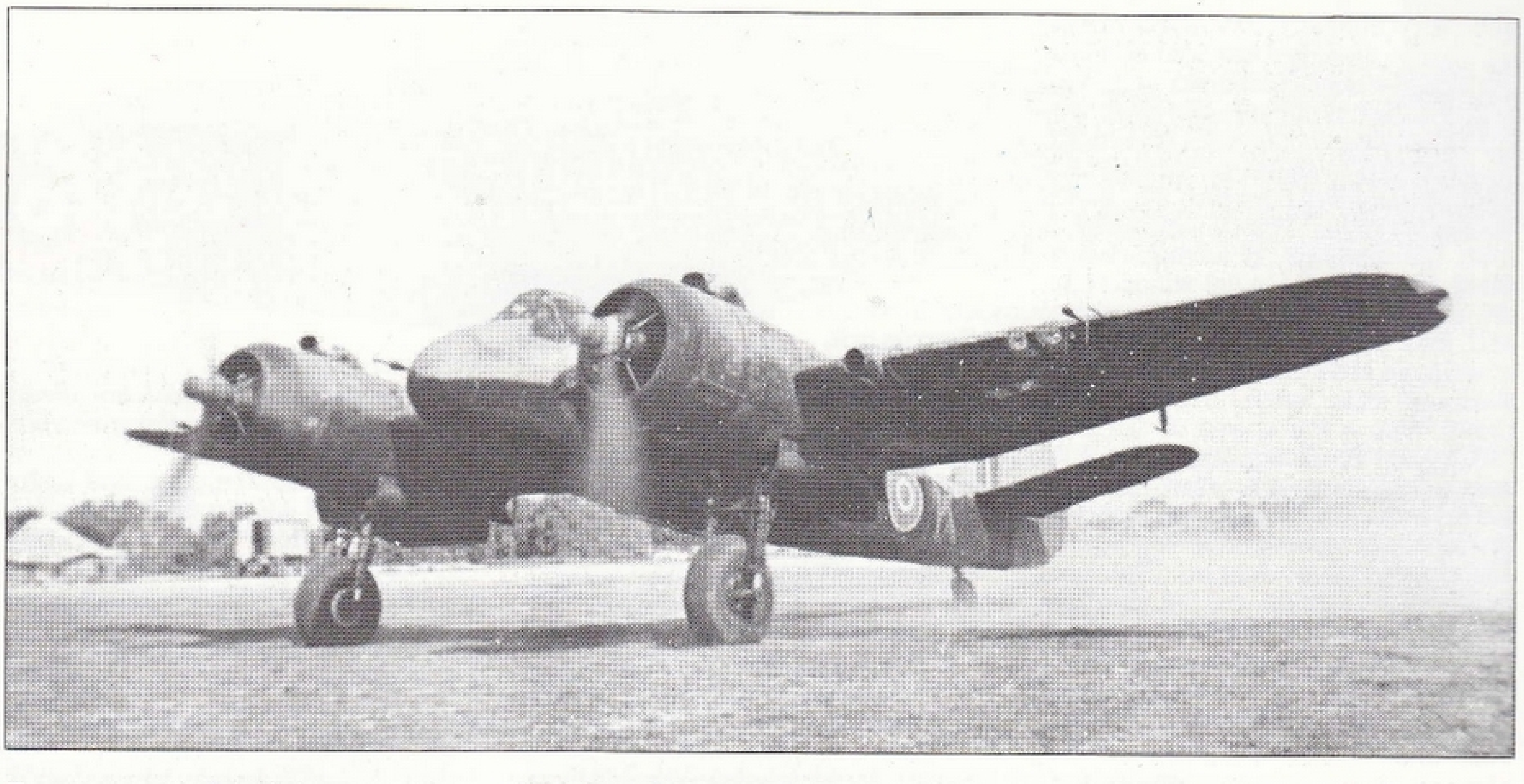


This Beaufighter Mk II served with one of the RAF's Polish squadrons, No. 307, from August 1941 until about mid-1942, when the Hercules-engined Beaufighter Mk VIF began to replace this Merlin-engined version.

First flown in prototype form on 17 July 1939, the **Bristol Beaufighter** took over the task of night-fighter defence from the makeshift Bristol Blenheim Mk IF fighter during the German night *Blitz* of the winter of 1940-1. Powered initially by 1,400-hp (1044-kW) Bristol Hercules III sleeve-valve radials, the **Beaufighter Mk IF** was equipped with AI Mk IV radar (characterized by a 'broad-arrow' transmitter aerial on the aircraft's nose) and, having undergone initial operational trials with the Fighter Interception Unit during the latter stages of the Battle of Britain, started delivery to RAF night-fighter squadrons in September 1940. Lack of familiarity with AI radar resulted in few combat successes during 1940, but in the last three months of the *Blitz* the Beaufighter began taking an increasing toll of German bombers. Home night-fighter squadrons equipped with Beaufighter Mk IFs included Nos 25, 29, 68, 141, 153, 219, 256, 600 and 604. Production was stepped up, and included 1,000 aircraft ordered from the 'shadow' factories, the 51st and subsequent aircraft being armed with six wing-mounted 7.7 mm (0.303-in) machine-guns in addition to the four belly-mounted 20-mm cannon to guard. Delays with improved Hercules radials resulted in the Rolls-Royce Merlin XX V-12 engine being selected to power the **Beaufighter Mk II**, the first production example of which was flown at Filton on 22 March 1941; the type entered Fighter Command service with No. 255 Squadron in July, followed by the Polish-manned No. 307 Squadron in August, and Nos 96 and 125 Squadrons in 1942. The **Beaufighter Mk III** (a lightened version) and the **Beaufighter Mk IV** (with Rolls-Royce Griffon engines) did not materialize as such, although a Beaufighter Mk II was experimentally flown with Griffon IIB

Three AI Mk IV-equipped Beaufighter Mk Is of No. 600 Sqn are seen here on a mission from Colerne during the winter of 1940-1.

engines. The **Beaufighter Mk V** featured a four-gun Defiant-type dorsal turret but was abandoned as this impeded the pilot's emergency exit. The **Beaufighter Mk VIF** then became standard as the RAF's principal night-fighter until the arrival of the de Havilland Mosquito Mk II, equipping as night-fighters Nos 29, 68, 96, 125, 141, 153, 219, 255, 256, 307, 600 and 604 Squadrons in the UK, and Nos 46, 89, 108, 144, 252 and 272 Squadrons in the Middle East during 1942-3. Among the home-based Beaufighter Mk VIF squadrons which moved to the Mediterranean theatre after the North African landings were Nos 255 and 600 Squadrons, and with the latter Flight Sergeant Downing and Sergeant Lyons in a Beaufighter Mk VIF shot down five Junkers Ju 52/3m transports in 10 minutes off Setif on 30 April 1943. In the Far East night-fighter Beaufighter Mk VIFs served with Nos 27, 89, 176 and 177 Squadrons, principally in the Calcutta area and over Burma. When it first arrived in service the Beaufighter was widely regarded as tricky to fly, particularly on one engine; in due course the fin area was increased and dihedral applied to the tailplane to improve lateral control, resulting in a fine night-fighter on which the RAF came to depend for two years in the mid-war period.



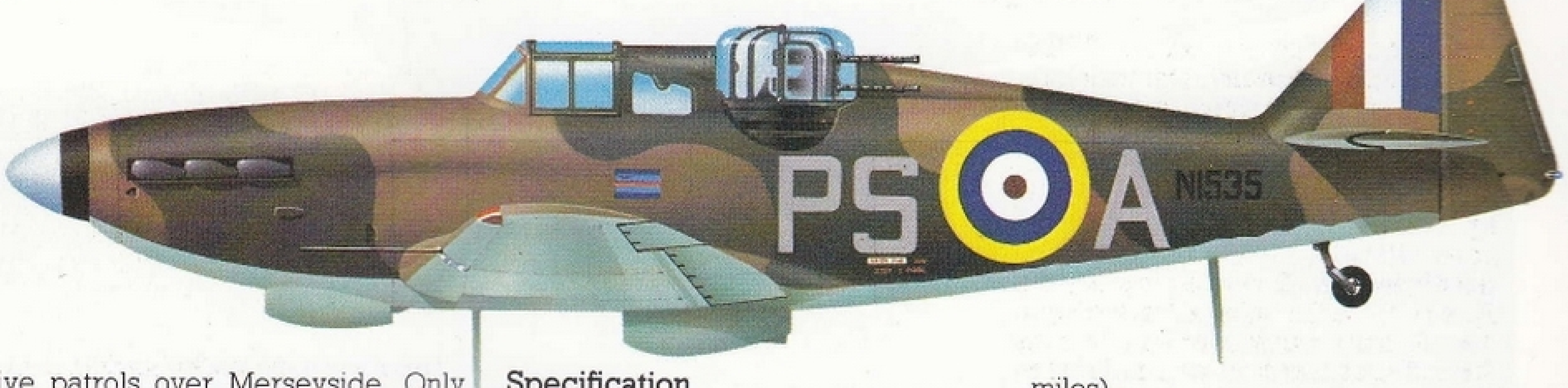
This Beaufighter Mk VIF has a dihedralled tailplane, but is still fitted with original AI Mk IV radar, with a 'harpoon' arrowhead on the nose and receiver dipoles on the wings. The RAF unit is not known, but it was home-based because in the Mediterranean inlet air filters were fitted.

Specification
Beaufighter Mk VIF

Type: two-seat night-fighter
Powerplant: two 1,670-hp (1245-kW) Bristol Hercules VI or XVI air-cooled sleeve-valve radial piston engines
Performance: maximum speed 536 km/h (333 mph) at 4755 m (15,600 ft); climb to 4570 m (15,000 ft) in 7 minutes 48 seconds; service ceiling 8075 m (26,500 ft); normal range 2382 km (1,480 miles)
Weights: empty 6623 kg (14,600 lb); maximum take-off 9798 kg (21,600 lb)
Dimensions: span 17.63 m (57 ft 10 in); length 12.70 m (41 ft 8 in); height 4.83 m (15 ft 10 in); wing area 46.73 m^2 (503 sq ft)
Armament: four 20-mm cannon in nose and six 7.7-mm (0.303-in) machine-guns in the outer wings, and one hand-held 7.7-mm (0.303-in) machine-gun in dorsal hatch

UK

Boulton Paul Defiant



An original Defiant Mk I of No. 264 Sqn (CO's aircraft), with turret fairings raised and ventral radio masts extended.

The saga of the **Boulton Paul Defiant Mk I** began with the type's short and disastrous service in RAF Fighter Command as a day fighter, entering combat at the time of the Dunkirk evacuation. By the opening of the Battle of Britain the Luftwaffe had the measure of the British two-seat turret fighter and decimated the two squadrons, Nos 141 and 264, so equipped. Hurriedly withdrawn as a day fighter at the end of August 1940, the Defiant transferred to night fighting and gained its first two night victories during the latter half of September. Indeed for many years the Defiant was credited with the highest number of victories per interception of any RAF night fighter during the night *Blitz*; only relatively recently has this distinction been correctly assigned to the Bristol Blenheim in the last four months of 1940, and to the Beaufighter in the first five months of 1941. Early operations by Defiants at night were carried out without the benefit of AI radar, the aircraft simply being day fighters flown at night in conjunction with searchlights. The first Defiant squadron formed specifically for night fighting was No. 307, staffed by Polish pilots with the RAF in September 1940, followed by Nos 255 and 256 Squadrons in November, and No. 151 Squadron in December. All these became operational in early 1941 when the first conversions to mount AI Mk VI radar became available.

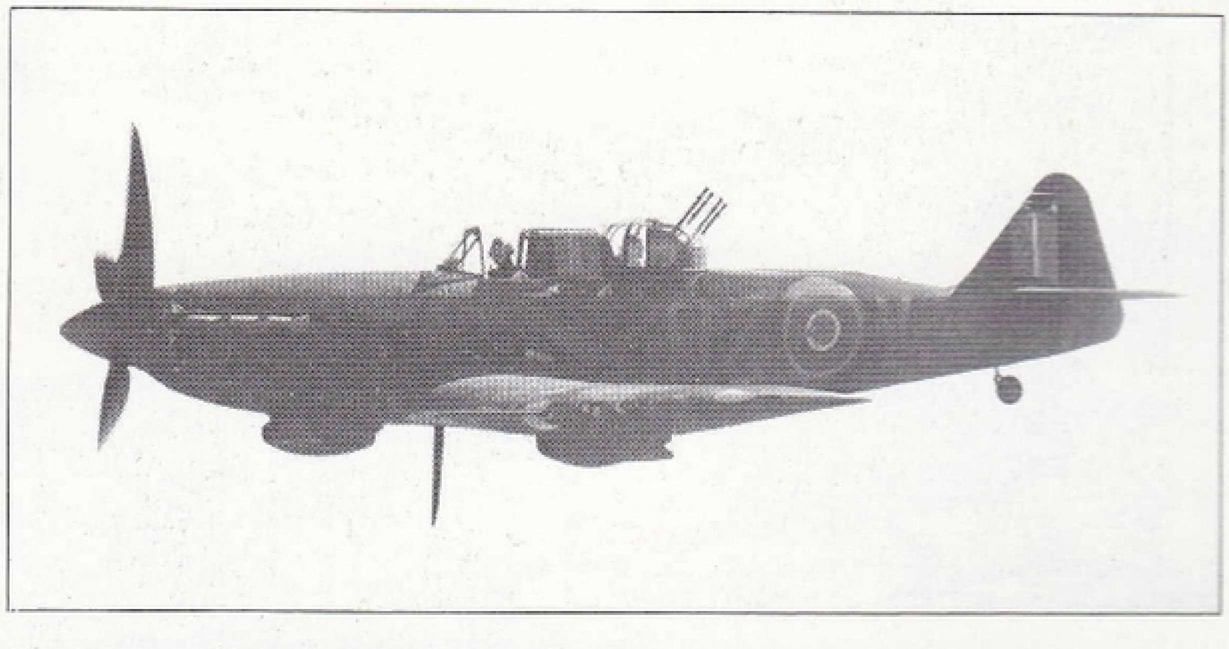
No. 85 Squadron received Defiants in January 1941 but flew only three operational sorties before discarding the aircraft on receiving orders to convert to the Douglas Havoc; No. 96 Squadron, on the other hand, flew Defiants from February 1941 until June 1942, initially to provide night defensive patrols over Merseyside. Only two other squadrons flew the Defiant as a night-fighter (apart from the ex-day squadrons, Nos 141 and 264), No. 125 being formed in June 1941 and No. 153 in October the same year. All remained in the UK.

The tactics employed by the Defiant night-fighter were as difficult as they were unique, as the turret guns (the only armament possessed by the aircraft) were seldom fired forward because their flash blinded the pilot. Instead the aircraft, using its AI radar, would engage in a long stern chase (for the Defiant was slow by comparison with other fighters), gradually draw alongside or beneath the enemy bomber before opening fire with its rifle-calibre guns. Quick direct hits were needed in vital parts of the target before the enemy gunners returned the fire or the German pilot took violent evasive action; by that time both Defiant crew members would have lost all night vision.

One other night duty was undertaken by night-flying Defiants when aircraft of No. 515 Squadron, specially equipped by TRE (Telecommunications Research Establishment), were used to jam enemy coastal radar from 1942 onwards.

Specification
Defiant Mk I

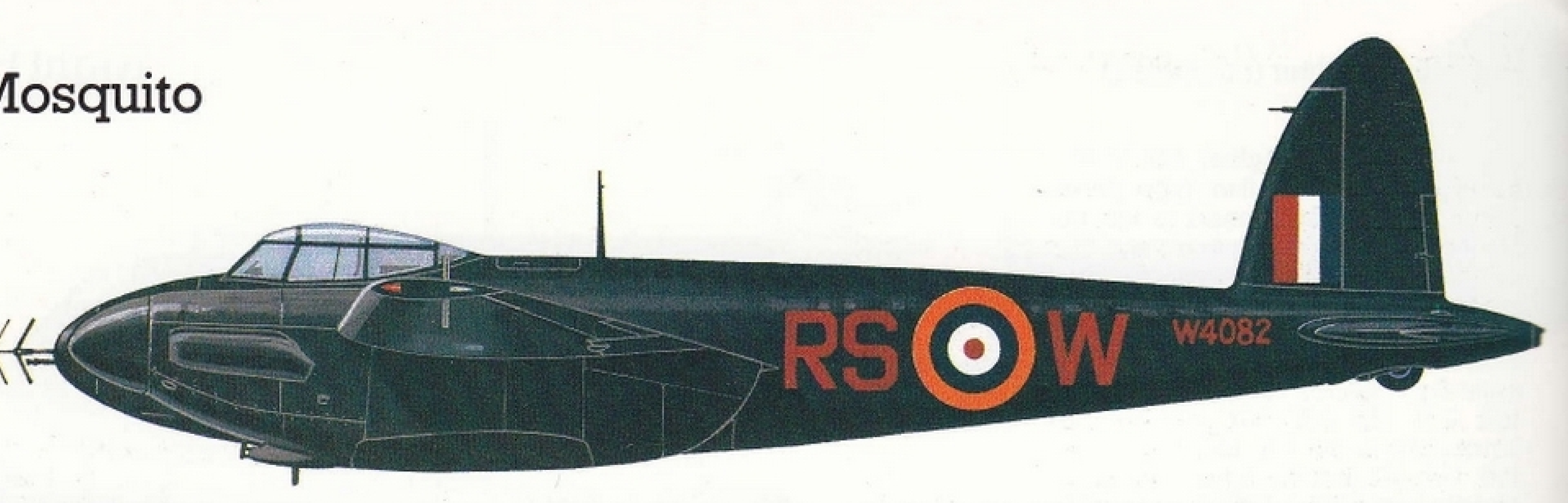
Type: two-seat night-fighter
Powerplant: one 1,030-hp (768-kW) Rolls-Royce Merlin III V-12 liquid-cooled piston engine
Performance: maximum speed 488 km/h (303 mph) at 5030 m (16,500 ft); initial climb rate 579 m (1,900 ft) per minute; service ceiling 9295 m (30,500 ft); range 756 km (470 miles)
Weights: empty 2722 kg (6,000 lb); maximum take-off 3788 kg (8,350 lb)
Dimensions: span 11.99 m (39 ft 4 in); length 10.77 m (35 ft 4 in); height 3.71 m (12 ft 2 in); wing area 23.225 m^2 (250 sq ft)
Armament: four 7.7-mm (0.303-in) Browning machine-guns in Boulton Paul power-operated gun turret with 600 rounds per gun



In contrast, this Defiant Mk II is seen much later in the war, serving as a night fighter with No. 151 Sqn, one of the longest-established night fighter units in the world (that was its special task in 1917).

UK

de Havilland Mosquito



W4082 was the fifth production Mosquito Mk II, delivered in January 1942. Note the exhaust flame dampers, which reduced flight performance.

Although originally conceived principally as an unarmed fast light bomber, the **de Havilland Mosquito** was also envisaged both as a photo-reconnaissance aircraft and as a night-fighter, the second aircraft flown (on 15 May 1941) being in fact the night-fighter prototype. This version differed from the bomber in having strengthened wing spars, a flat windscreen, an armament of four 20-mm cannon and four 7.7-mm (0.303-in) machine guns in the nose, crew entry through a starboard side hatch, and AI Mk IV radar. With a top speed of 595 km/h (370 mph), the **Mosquito NF.Mk II** (of which 466 were produced) entered service with No. 23 (Fighter) Squadron at Ford in May 1942, followed by No. 157 Squadron in August. The next night-fighter version was the **Mosquito NF.Mk XII**, 97 of which were produced by fitting AI Mk VIII radar in Mk IIs, the four machine-guns being removed; it first joined the Polish-staffed No. 307 Squadron in December 1942; 270 **Mosquito NF.Mk XIII** aircraft were similar but were newly built. One hundred Mk IIs were converted to become **Mosquito NF.Mk XVII** aircraft by installation of the American centimetric AI Mk X in a somewhat enlarged nose radome. A derivative of this version, the **Mosquito NF.Mk XIX**, of which 220 were produced from new, operated at an increased all-up weight and were powered by 1,635-hp (1219-kW) Rolls-Royce Merlin 25s, this version serving with eight RAF squadrons. A parallel design was initiated to produce a high-altitude night-fighter, the **Mosquito NF.Mk XV**, to combat the high-flying Junkers Ju 86P reconnaissance aircraft which started flying over the UK in 1942; with a span increased to 19.05 m (62 ft 6 in), armament reduced to four rifle-calibre machine guns, and 1,710-hp (1275-kW) Merlin 76/77s, this aircraft was flown to 13260 m (43,500 ft), but was never flown in combat by the single squadron, No. 85, thus equipped. The last wartime night-fighter Mosquito was the **Mosquito NF.Mk 30**, which first equipped No. 219 Squadron at Bradwell Bay in July 1944 and went on to join a dozen other squadrons during the last year of the war. Powered by Merlin 72/73, 76/77 or 113/114 engines, this version had a top speed of 655 km/h (407 mph) and an operating ceiling of 11580 m (38,000 ft). Some 230 examples of this, the best of all Mosquito night-fighters produced during the war, were built.

The Mosquito was undoubtedly the finest Allied night-fighter of the war, replacing almost all Bristol Beaufighter night fighters in service in northern Europe by 1944, and being employed not only for home defence but also night intruder and bomber support/night escort duties. The only enemy night-fighter capable of matching the Mosquito was the superb Heinkel He 219 (as well as the few night-fighter Me 262s), but these were so few in number as scarcely to affect the scale of night operations over the continent. The most famous of all Mosquito night-fighter pilots was Group Captain John Cunningham, who later became chief test pilot at the de Havilland company.

This early Mosquito Mk II is running up on the ground, despite the fact that the main access hatch to the AI Mk IV radar transmitter appears to have been removed.

Specification

Mosquito NF.Mk 30

Type: two-seat night fighter/bomber support aircraft

Powerplant: two 1,710-hp (1275-kW) Rolls-Royce Merlin 76 V-12 liquid-cooled piston engines

Performance: maximum speed 655 km/h (407 mph) at 8535 m (28,000 ft); climb to 4570 m (15,000 ft) in 7 minutes 30 seconds; service ceiling 11885 m (39,000 ft); normal range 2092 km (1,300 miles)

Weights: empty 6985 kg (15,400 lb); maximum take-off 9798 kg (21,600 lb)

Dimensions: span 16.51 m (54 ft 2 in); length 12.73 m (41 ft 9 in); height 4.65 m (15 ft 3 in); wing area 40.41 m^2 (435 sq ft)

Armament: four forward-firing 20-mm Hispano cannon under nose

UK

Hawker Hurricane Mk II

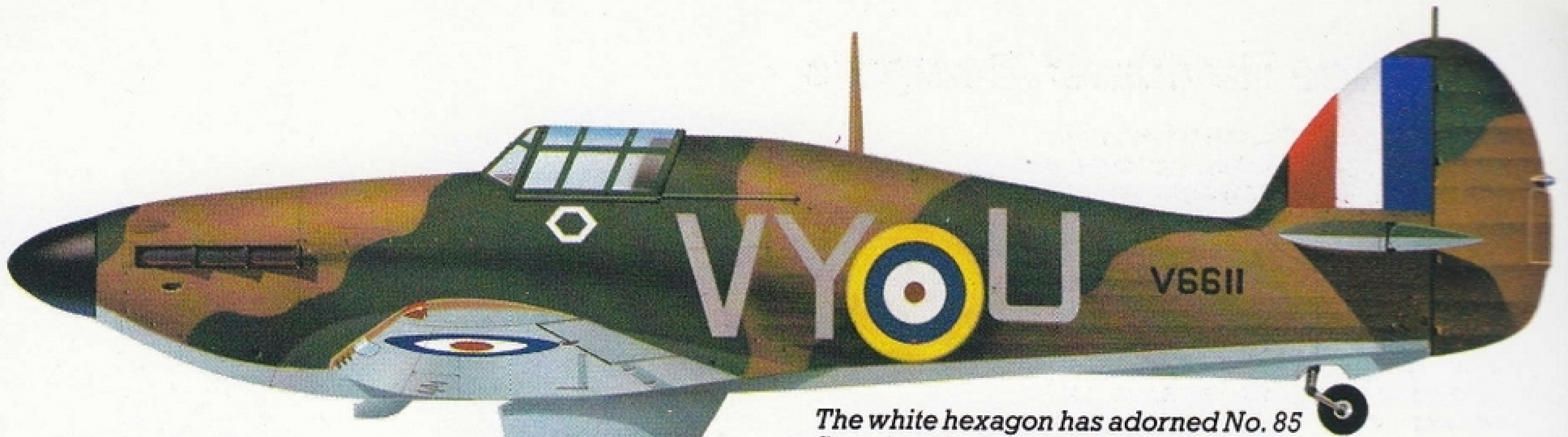
From its earliest service days the **Hawker Hurricane** single-seater proved a pleasant aeroplane to fly at night (unlike the Supermarine Spitfire), and as early as the Battle of Britain Hurricanes were regularly flying night patrols to complement those of the night-fighter Bristol Blenheims. For example No. 92 (Fighter) Squadron operated a detached flight at Bibury in Gloucestershire for this work. As the daylight battle petered out in October the Hurricane was increasingly flown at night and with the introduction of the more powerful **Hurricane Mk II** with progressively heavier armament (eight machine-guns in the **Hurricane Mk IIA**, 12 machine-guns in the **Hurricane Mk IIB** and four 20-mm cannon in the **Hurricane Mk IIC**), the aircraft not only performed night defensive patrols but also became increasingly used as an intruder over German bomber bases in northern France and the Low Countries. Among the best known night fighter/intruder squadrons to fly Hurricane Mk IIs in 1941-2 were Nos 1, 3, 46, 79 and 87; to them was ascribed the destruction of 52 enemy aircraft, 16 coastal vessels, 105 road vehicles and 17 locomotives during the last six months of 1941. Without question the most successful pilot of this mid-war period was Flight Lieutenant Karel Kuttelwascher (a Czech veteran of the Battle of Britain) of No. 1 (Fighter) Squadron, who scored his first 'intruder' victory, a Junkers Ju 88, on 1 April 1942 and went on to shoot down 14 more enemy aircraft (seven Dornier Do 217s, five Heinkel He 111s, a Dornier Do 17 and another Ju 88) in the next eight weeks, for which he was

After the mauled No. 87 Sqn returned from France in June 1940 it was remustered as a night fighter unit, and in 1942 one of its aircraft was this Langley-built Hurricane Mk IIC, flown by the CO.

awarded two DFCs: among his victories were three He 111s shot down over St André in the space of four minutes at midnight on 4/5 May, no mean feat for a single-seater without the benefit of radar.

The specialist night intruder Hurricane differed from its day fighter counterpart only in being painted matt black overall and having small anti-glare panels between the engine exhaust stubs and the pilot's windscreen. Hurricane Mk IIs provided the first night-fighter equipment in the Middle East with the arrival of No. 213 Squadron in the Canal Zone in May 1941, and in May 1943 Hurricane Mk IICs with pilot-AI radar served with No. 176 Squadron in the Calcutta area.

Finally, mention should be made of the Turbinlite squadrons which, using searchlight- and AI-equipped Douglas Havocs and Douglas Bostons to locate enemy raiders, also flew Hurricane Mk IIBs and Mk IICs during 1942; an almost total absence of success, together with rapid development of AI radar, caused this wasteful and fruitless experiment to be abandoned in January 1943.



The white hexagon has adorned No. 85 Sqn aircraft since 1916; since this Hurricane Mk I, No. 85 Sqn has flown most RAF night fighter types.

Specification
Hurricane Mk IIC

Type: single-seat night-fighter/intruder

Powerplant: one 1,280-hp (954-kW) Rolls-Royce Merlin XX V-12 liquid-cooled piston engine

Performance: maximum speed 546 km/h (339 mph) at 6705 m (22,000 ft); climb to 6095 m (20,000 ft) in 9 minutes 6 seconds; service ceiling 10850 m (35,600 ft); normal night-fighting range 740-km (460 miles)

Weights: empty 2631 kg (5,800 lb); maximum take-off 3583 kg (7,800 lb)

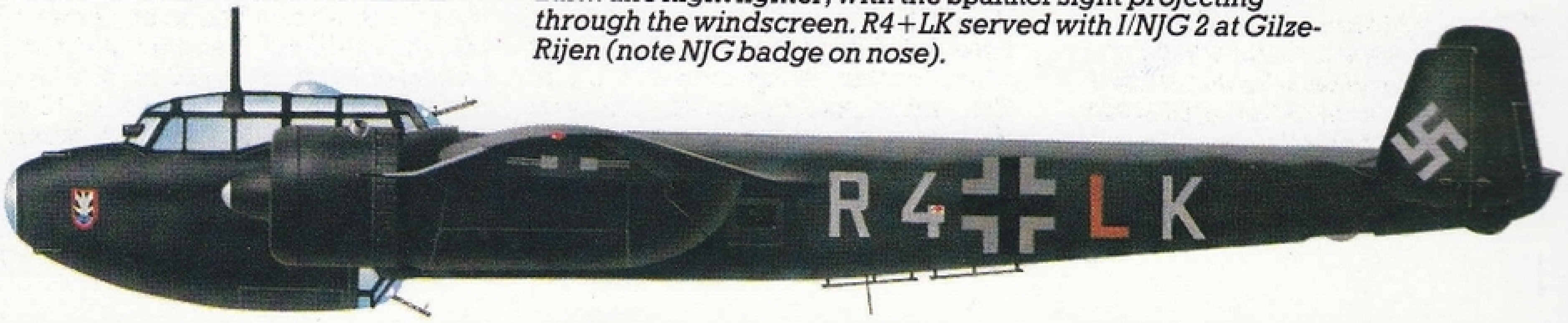
Dimensions: span 12.19 m (40 ft 0 in); length 9.75 m (32 ft 0 in); height 4.00 m (13 ft 1½ in); wing area 23.92 m^2 (257.5 sq ft)

Armament: four wing-mounted 20-mm Hispano cannon, plus (intruder version) two 227-kg (500-lb) bombs

GERMANY

Dornier Do 17, Do 215 and Do 217

The Do 17Z-10 Kauz II was the first sensor-equipped Luftwaffe night fighter, with the Spanner sight projecting through the windscreen. R4+LK served with I/NJG 2 at Gilze-Rijen (note NJG badge on nose).



The **Dornier Do 17** came to be employed in the night fighting role not so much because it was particularly suited to the task as for its availability in growing numbers as it approached the end of its service as a front line bomber. The opening of RAF bombing attacks on Germany in May 1940 caught the Luftwaffe wrong-footed, without an organized night-fighter defence, and although such a force was quickly established using the Messerschmitt Bf 110 and Junkers Ju 88C, consideration was also given to the use of other bombers converted to the night-fighter role. A standard Dornier Do 17Z-3 was therefore fitted with the nose of a Ju 88C-2 carrying an armament of one 20-mm MG FF cannon and three 7.92-mm (0.31-in) MG 17 machine-guns. Termed the **Do 17Z-6 Kauz I** (Screech Owl I), this version was found to be unsatisfactory and was abandoned. A fresh start was made with an entirely new nose accommodating two 20-mm cannon and four 7.92-mm (0.31-in) machine-guns together with an infra-red detection equipment (*Spanner Anlage*) operating in conjunction with a Q-Rohr sighting screen. Nine such **Do 17Z-10 Kauz II** aircraft were completed, and these served for a short time late in 1940 with I/NJG 2; the infra-red equipment was found to be too sensitive for operational use, however, and no further Do 17s were converted. A similar conversion was made to the Do 215 as the **Do 215B-5**, also with two cannon and four machine-guns, this version first joining 4./NJG 2 during the spring of 1941 for intruder sorties over British bomber bases and, following a fair degree of success (18 RAF bombers were lost to intruders between April and June 1941), further examples equipped I, III and IV/NJG 1 and I and II/NJG 2 later in that year. Rather more attention was paid to producing night-fighter versions of the Do 217, the first of which, the **Do 217J-1** night intruder, entered service in the summer of 1942, followed by the **Do 217J-2** night-fighter with Lichtenstein BC radar. These served in small numbers with NJG 1 and NJG 2, and equipped the whole of NJG 3 and III/NJG 4. The final variant, the **Do 217N**, existed in numerous forms of which one, the **Do 217N-1/U3**, often carried four 20-mm cannon in a *schräge Musik* upward-firing installation, but with a speed of around 525 km/h (326 mph) night interception was little more than speculative. Nevertheless Do 217Ns, of which some 200 are said to have been built, served with NJG 3 and NJG 4, as well as II/NJG and II/NJG 2 in th Mediterranean theatre in 1943. However, their cost and the disruption to bomber production led to their discontinuation by the middle of that year in favour of the established Bf 110 and Ju 88.

Specification
Do 17Z-10 Kauz II

Type: three-seat night-fighter

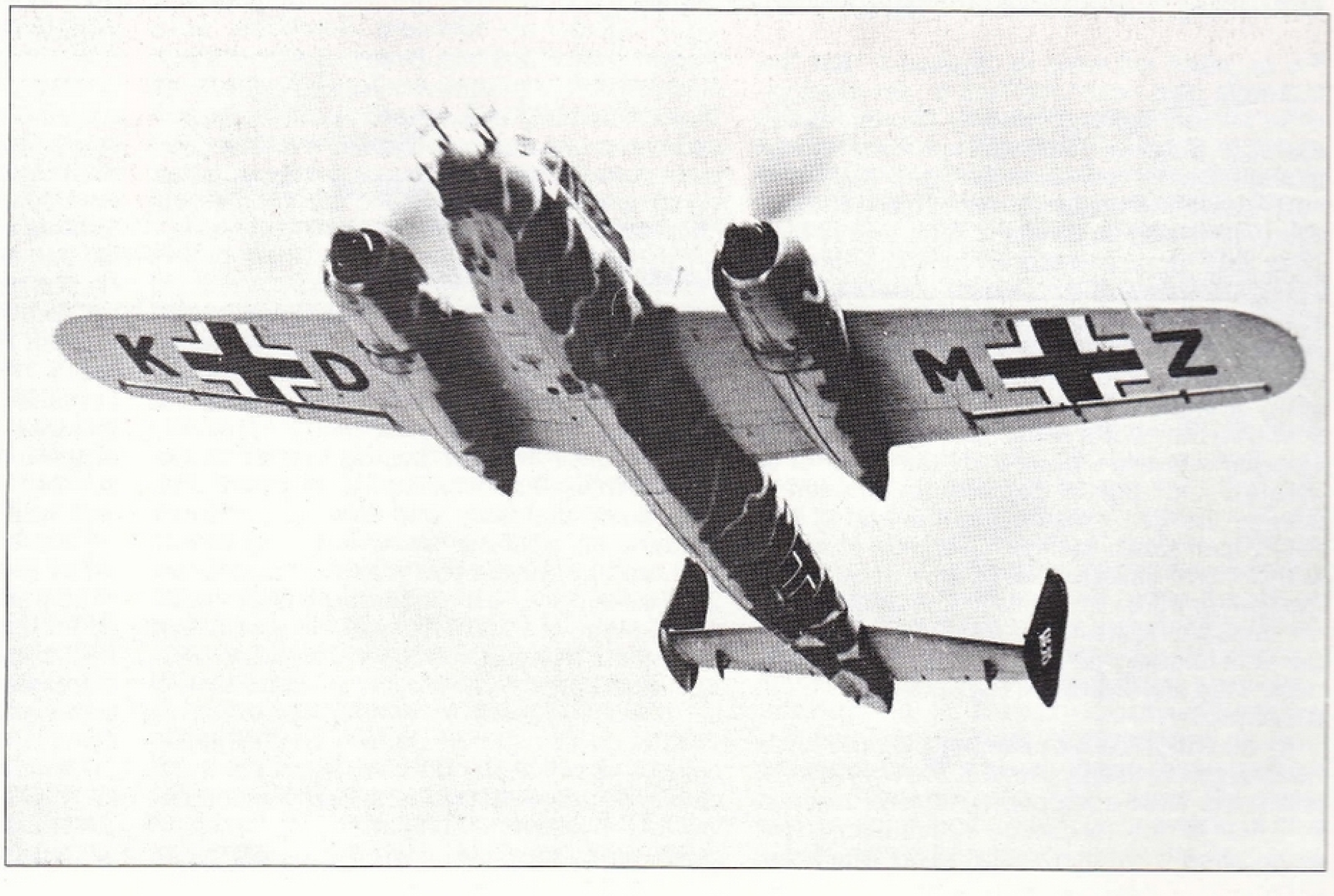
Powerplant: two 1,000-hp (746-kW) Bramo 323P nine-cylinder air-cooled radial piston engines

Performance: maximum speed 415 km/h (258 mph) at 4000 m (13,125 ft); initial climb rate 290 m (950 ft) per minutes; service ceiling 6650 m (21,820 ft); maximum range 1270 km (789 miles)

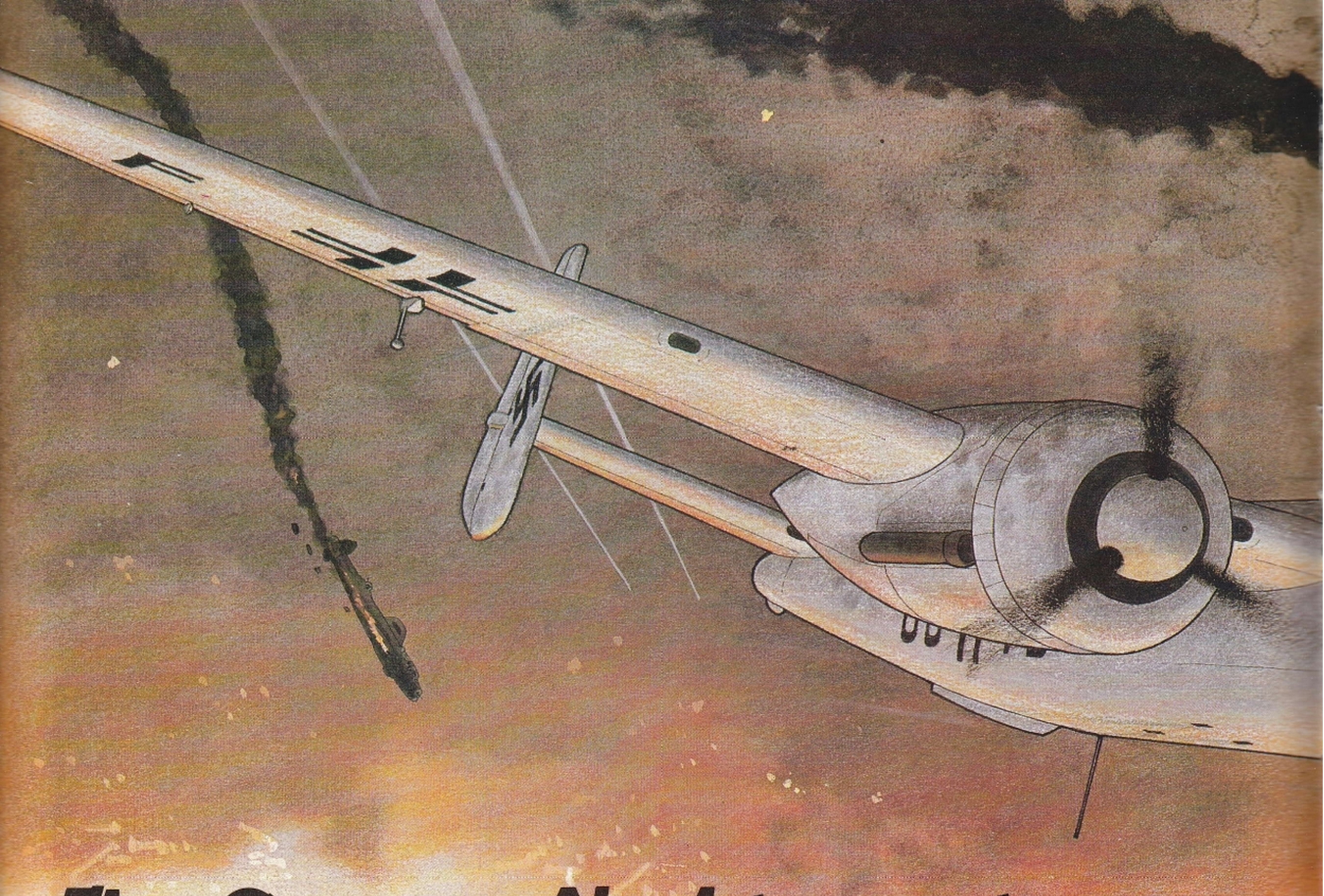
Weights: empty 5150 kg (11,354 lb); maximum take-off 8445 kg (18,618 lb)

Dimensions: span 18.00 m (59 ft 0½ in); length 16.00 m (52 ft 6 in); height 4.55 m (14 ft 11¼ in); wing area 55.00 m^2 (592 sq ft)

Armament: two 20-mm MG FF cannon and four 7.92-mm (0.31-in) MG 17 machine-guns in nose, and up to four 7.92-mm (0.31-in) MG 17 guns in lateral, dorsal and ventral positions



KD+MZ were the Dornier factory codes of the Do 217J development aircraft, seen here with the bomb bay of the Do 217J-1 but the Lichtenstein BC (FuG 202) radar of the Do 217J-2. Operational Do 217J-2s were all-black.



The German *Nachtexperten*

The RAF's night bomber offensive against Germany provided the impetus for intensive development of night-fighting equipment, aircraft and tactics. Despite this the German night fighter pilots managed to exact a heavy toll on the vast numbers of lumbering heavy bombers which flew over Germany.

For six years, following its creation in 1934, the Luftwaffe paid scant attention to the development of night-fighters, it being thought inconceivable that any European air force would indulge in night attacks on Germany that could not be defeated by the extensive flak defences which were also established. When, on 15 May 1940, RAF bombers started attacking targets inside Germany, an immediate expedient was sought by reclassifying a single *Zerstörergruppe* (heavy fighter group), I/ZG 1 under Hauptmann Günther Radusch, as a night fighting unit, I/NJG 1, in the following month. Little success attended the efforts of this unit, and on 20 July Goering ordered Oberst Josef Kammhüber to create a night-fighter defence organization to counter the RAF's attacks. By the end of July NJG 1 had grown to three *Gruppen*, of which II/NJG 1 flew Junkers Ju 88Cs under Hauptmnn Karl Heyse from Gilze Rijen in The Netherlands on intruder operations over RAF bomber bases in England, achieving considerable success. This unit was later expanded into a full *Geschwader*.

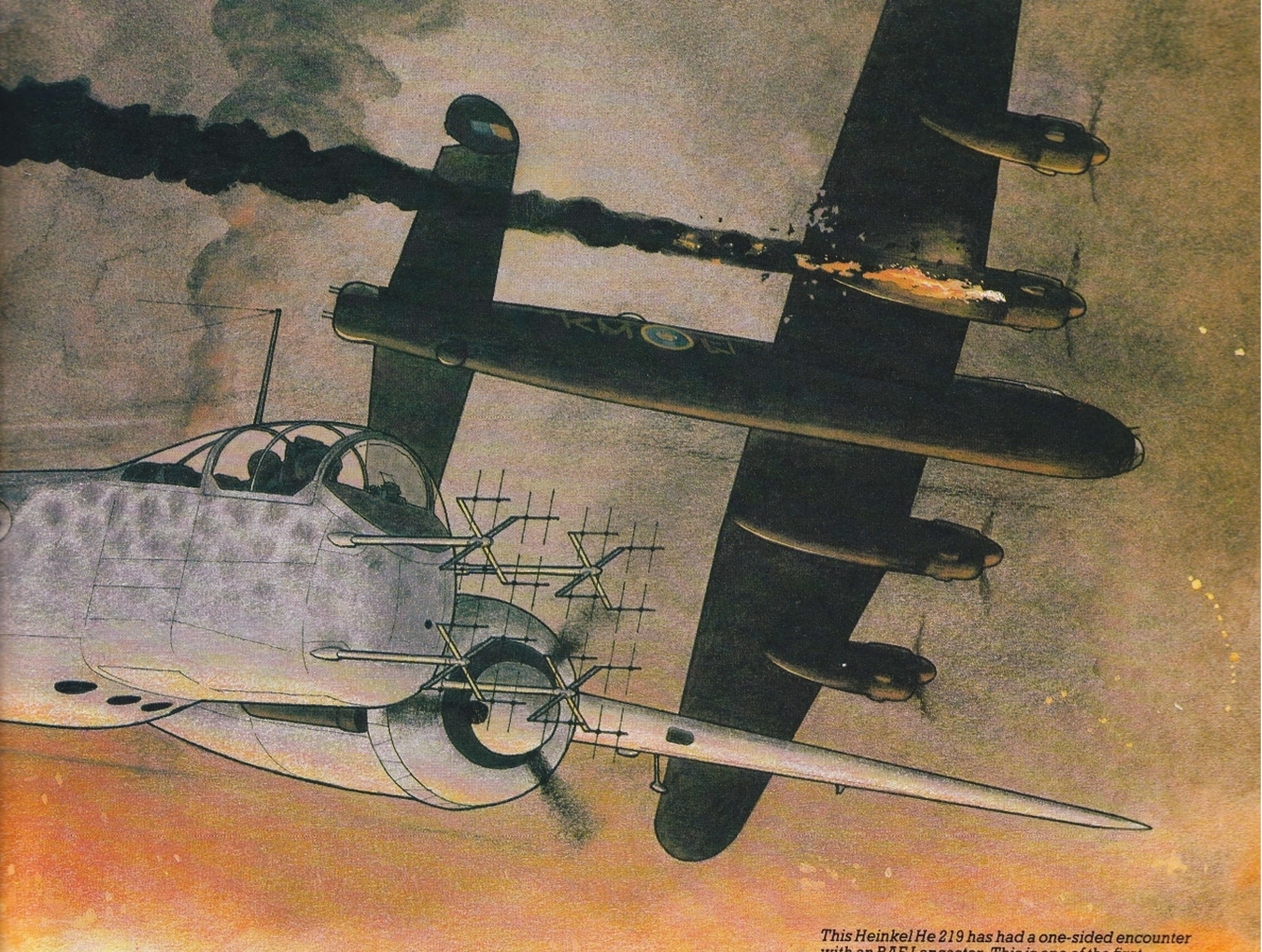
By mid-1941 the German night-fighter force had still grown to only a total of five *Gruppen*, of which four were equipped with Messerschmitt Bf 110s. In the meantime Kammhüber had established a ground radar chain which extended from the Swiss border north to Denmark, each radar station comprising a pair of 'Giant Wurzburg' sets, one to track the enemy raider and one the night-fighter, to whose pilot were passed radio instructions guiding him to a visual contact. This was called the *Himmelbett* (four-poster bed) system.

Radar experiments

German progress in the development of airborne radar was extremely slow in 1941, being then almost two years behind that of the British. Instead experiments were being conducted using Bf 110s carrying an infra-red sensing device (*Spänner Anlage*), but this proved far too difficult to use and was later abandoned. The Telefunken company was then instructed to produce an airborne radar in the spring of 1941, and by August that year the first set, the Lichtenstein BC, was undergoing flight trials; with a range of about 3700 m (4,045 yards), this equipment entered service in February 1942. By then the night-fighter force comprised three full *Nachtjagdgeschwader* with some 180 Bf 110s, 60 Ju 88s and 20 Dornier Do 217 night-fighters, of which all but about 30 aircraft were deployed to defend the Reich from the increasing RAF bombing campaign.

As yet, so recalcitrant were the early radar sets proving that there were few outstanding names among German night-fighter pilots, of whom Hauptmann Ludwig Becker of II/NJG 1 (25 victories) led the field. Becker was awarded the Knight's Cross on 1 July 1942.

1942 was the great formative year for RAF Bomber Command under Sir Arthur Harris, with the mounting of the first '1,000-bomber' raids against Köln, Essen and Bremen, the introduction of the Avro Lancaster and de Havilland Mosquito bombers, the first use of the 3629-kg (8,000-lb) bomb, and the formation of the Pathfinder force; in the year the tonnage of bombs dropped on German industrial towns trebled. Faced with a ghastly spectre of destruction by night, the Luftwaffe redoubled its efforts to improve its night-fighters, and by the beginning of 1943 all were equipped with Lichtenstein BC or the simplified FuG 212 C-1 radar. Improvements were being introduced into the Kammhüber reporting and control system, with the result that losses among the British bombers increased rapidly during the winter of 1942-3. The introduction of the 'bomber stream', led by experienced Pathfinder crews, undoubtedly improved the effectiveness of RAF bombing but certainly contributed to this increase in losses as it now only required German night-fighters to intrude into the streams to achieve multiple victories among the massed raiders. Major Helmut Lent, *Kommandeur* of IV/NFGG 1, scored his 50th victory on 8 January 1943 during an RAF raid on the Ruhr, emerging as front runner of the *Nachjagdverband*.



This Heinkel He 219 has had a one-sided encounter with an RAF Lancaster. This is one of the first He 219A-2 production machines, which unlike all subsequent variants had the old Lichtenstein C-1 radar with 32 short dipole aerials.

Hitherto the RAF's Mosquito bombers had operated almost unscathed over the continent, no Luftwaffe night-fighter possessing a performance approaching that of the superb British light bomber. But on 15 November 1942 there had flown the prototype of a new German custom-designed night-fighter, the Heinkel He 219, an aircraft that arrived in limited service with the Luftwaffe at Venlo in April 1943. On its first combat sortie, flown by Major Werner Streib against an RAF bomber stream heading for Düsseldorf on the night of 11/12 June, the He 219 destroyed six four-engine bombers in 30 minutes with its devastating six-cannon armament. It was to Streib, more even than to Kammhüber, that the German night-fighter arm owed most, for it was he who was to become Inspector of Night-Fighters during the final year of the war; moreover, having gained the Luftwaffe's initial night victory way back on 20 July 1940, he went on to command NJG 1 and was primarily responsible for ensuring the introduction into service of all the most successful tactics and equipment of the German night-fighter arm. Despite a succession of staff appointments, he finished the war with a total of 65 night victories and had been awarded the Swords and Oakleaves to the Knight's Cross.

During the first 10 nights of operations by the small number of Venlo-based He 219s, their pilots destroyed 20 British bombers, including six Mosquitoes. It was at this point that, faced with catastrophic losses, RAF Bomber Command introduced 'Window', metal foil strips which, discharged in huge quantities by the bombers as they approached the German coast, effectively saturated the enemy radar screens with a mass of spurious signals and, in the Battle of Hamburg between 24 July and 3 August 1943, rendered the close control of night-fighters impossible.

Improvised tactics

The Germans now quickly improvised, dividing their night fighting tactics between close control and freelance interception, codenamed respectively *zahme Sau* (tame sow) and *wilde Sau* (wild sow). The former tactic, advocated by Oberst von Lossberg, consisted simply of a running commentary on the location and course of the bomber stream broadcast to patrolling night-fighter pilots, who then navigated themselves into the stream and attacked the bombers as best they could between the clouds of 'Window'. The latter, capable of being employed only on moonlit nights, involved the use of single-seat day fighters at night, a new *Jagdgeschwder*, JG 300, being created under its originator, Major Hajo Hermann; following considerable success during 1943, this was expanded into Jagddivision 30, comprising JG 300, JG 301 and JG 302. Despite the tactic's success, the strain on Hermann's pilots was too great and losses among the Messerschmitt Bf 109Gs and Focke-Wulf Fw 190As, as a result of excessive wear and tear, were prohibitive, for the same aircraft were also combating the American daylight bombers; with the onset of winter, bad weather frequently caused accidents, and operations by these aircraft gradually declined, except under the most favourable conditions.

Meanwhile the Luftwaffe had introduced new tactics and equipment to offset the RAF's jamming. The first of these, conceived by an armourer serving with II/NJG 5, Paul Mahle, consisted of a pair of 20-mm (or later 30-mm) cannon mounted amidships in the Bf 110, Ju 88 and He 219, so as to fire obliquely forwards and upwards at an angle of between 70° and 80°. This installation, codenamed *schräge Musik* (Jazz), enabled the night-fighter, whose approach to the bomber had consisted of a stern chase, to position itself below the target and open fire at the raider's engines and fuel tanks. It was first used successfully by Gefreiter Hölker of 5./NJG 5, who shot down two heavy bombers on 17 August; shortly afterwards Leutnant Peter Ehrardt destroyed four more in the space of 30 minutes. Being thus attacked from a blind arc, the RAF crews for many months remained blissfully unaware of the lethal German tactics, and the British bombers continued over Germany without ventral armament.

Also unsuspected by the RAF was the Germans' ability to home on to the signals transmitted by the British H2S blind-bombing radar. Indeed, as many RAF crews switched on this equipment at the beginning of their outward journey as an aid to navigation, German night-fighters were often already well-established inside the bomber stream before the 'Window' dropping began. Much later the RAF bombers began to carry a new device, codenamed 'Monica', to give warning of the approach from the rear of German night-fighters; the Germans in turn developed their FuG 277 Flensburg radar which enabled their night-fighters to home on to Monica!

This was the night war scenario in which a host of German pilots excelled while their home blazed below. Hauptmann Manfred Maurer, who flew He 219s with NJG 1 and NJG 5 during the second half of 1943, destroyed 30 Halifaxes and Lancasters; multiple victories had been scored since the early days of the night war, the first pilot to destroy five four-engine aircraft in one night being Hauptmann Reinhold Knacke who, as *Staffelkapitän* of 3./NJG 1, achieved this feat on 17 November 1942. The first to gain six victories was Hauptmann Herbert Lütje, *Staffelkapitän* of 8./NJG 1, on 13/14 May 1943 over the Ruhr. Two months later the famous pilot, Major Heinrich Prinz zu Sayn-Wittgenstein, destroyed seven enemy aircraft in a single night; he also shot down six RAF heavy bombers over Berlin on the night of 1/2 January 1944 but, on 21 January 1944, after destroying five bombers, he was himself shot down and killed by an RAF Mosquito. With a night victory total of 83 (of which 29 were gained over the Eastern Front) Prinz Heinrich was third highest-scoring German night-fighter pilot (after Schnauffer and Lent), and was awarded the Swords and Oakleaves to the Knight's Cross.

The greatest multiple-scorer was Hauptmann Martin Becker of I/NJG 6, who gained six victories over Frankfurt on the night of 23 March 1944, following this with seven more during the disastrous RAF raid on Nuremberg only a week later, exceeding this with nine victories over Wuppertal on 14 March 1945.

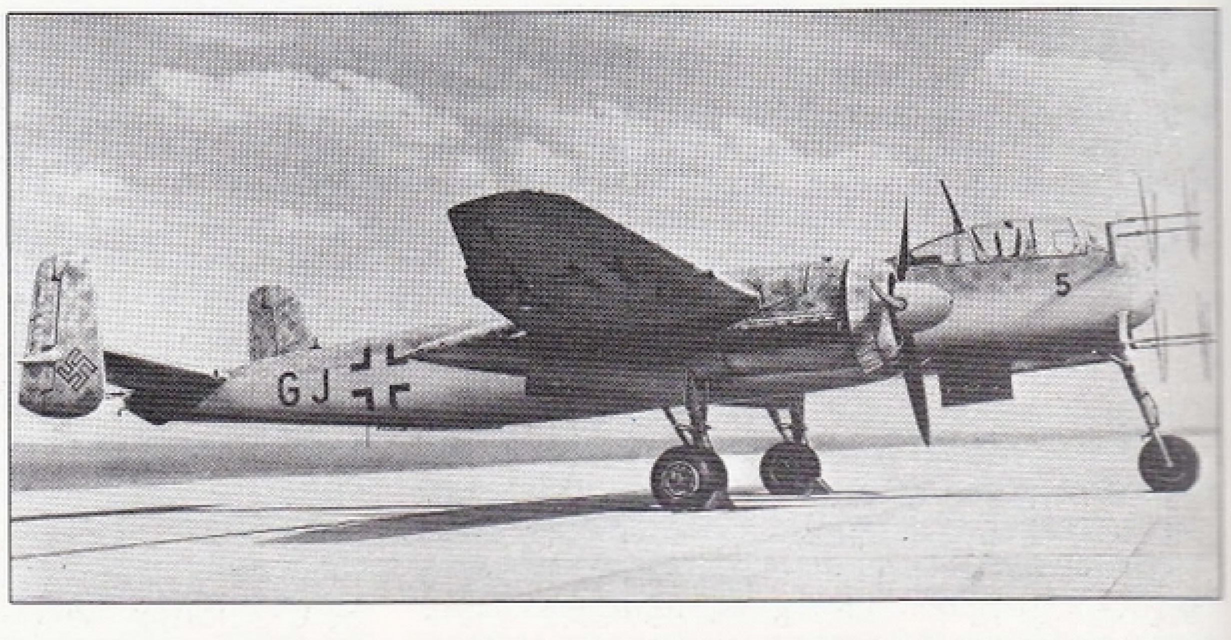
Top of the list of German night-fighter pilots was Major Heinz-Wolfgang Schnauffer who transferred to the *Nachtjagdverband* relatively late in the war, in the spring of 1942. During his first year with II/NJG 1 he was only able to shoot down 21 RAF aircraft, but in the final two years of the war went on to add exactly 100 more. His radio operator Fritz Rumpelhardt shared in all of these, and his gunner Wilhelm Gänsler in 98 of them; both were awarded Knight's Crosses, while Schnauffer himself held the Diamonds, Swords and Oakleaves, only Lent among the night-fighter pilots sharing this distinction. Schauffer's total of 121 victories was amassed in the course of only 164 combat sorties.

Without in any way detracting from the achievements of Allied pilots, those of the German night-fighter arm should be seen in perspective. The highest scoring RAF night-fighter pilots were Wing Commander B.A. Burbridge (21 victories) and Wing Commander J.R.D. Braham (19 victories), the majority of whose successes were gained as intruder and night escort pilots over enemy territory where opportunities to shoot 'sitting ducks' were rarely gained. For that is largely what the RAF Lancasters and Halifaxes were, tied into a bomber stream, their pilots ordered to maintain a specific course and altitude in a hostile environment, their gunners cramped into freezing turrets as they searched the dark skies for darker silhouettes, not just for an occasional raid but night after night until the squadron records indicated that they had completed the statutory number of sorties to constitute a tour of operations. Perhaps it was little wonder therefore that more than 200 German night-fighter pilots surpassed the score of the RAF's best.

GERMANY

Heinkel He 219 Uhu

When first conceived as a high-performance general purpose aircraft in 1940, the **Heinkel He 219 Uhu** (owl) attracted little interest as it appeared not to approximate to any specific requirement by the Luftwaffe. But when during the winter of 1941-2 the RAF night bombing offensive began to assume serious proportions, Heinkel was asked to proceed with the He 219 as a night-fighter. Despite the loss of most of the design drawings in an RAF raid on Rostock, the prototype **He 219 V1** was flown on 15 November 1942, powered by two Daimler-Benz DB 603A engines, and early in the following year the aircraft was flown by Major Werner Streib in competition with the Ju 188S and emerged winner, after which a production order for 300 aircraft was placed. The two-seat shoulder-wing fighter was thus the first aircraft with nosewheel landing gear to enter service with the Luftwaffe, the first few pre-production examples reaching I/NJG 1 under Major Streib at Venlo in April 1943. Equipped with FuG 220 Lichtenstein SN-2 radar and armed with four 20-mm MK 103 cannon, these aircraft destroyed 26 RAF aircraft, including six of the much-feared de Havilland Mosquitoes, in their first 10 days of operations. Numerous *Rüstsatz* conversion kits were produced to provide different armament combinations, and the first production night-fighter version was the **He 219A-2/R1** with two 20-mm cannon in the wing roots and two 30-mm cannon in a ventral pack. Just as deliveries of the He 219 were getting under way, its future was threatened when Erhard Milch recommended abandoning it in favour of the Junkers Ju 88G whose performance was adequate to combat RAF heavy bombers; however, when the Mosquitoes started to bomb Berlin and were able to outpace the Ju 88 and Messerschmitt Bf 110, production of the He 219 was stepped up again. In due course the **He 219A-7** was standardized with DB 603G engines, and in the **He 219A-7/R1** version no less than eight cannon, including two 30-mm guns in the upward-firing *schräge Musik* installation, were carried. Although He 219 fighters were issued to numerous units, the principal deliveries were to NJG 1 at Arnham, St Trond and Handorf, and to the special anti-Mosquito unit NJGr 10 based near Berlin. Because of the prevarication engendered by Milch, production of the He 219 reached only 268 aircraft before the end of the war; there is no doubt that had production gone ahead without interruption early in 1943 large numbers of He 219s would have had it in their power to inflict prohibitive losses on Bomber Command long before the end of the Battle of Berlin early in 1944.



Simplified national markings were common in the final year of the war, as seen on this He 219A-7 development aircraft which bears factory codes. This was to become the most important service variant.

Specification

He 219A-7/R1 Uhu

Type: two-seat night fighter

Powerplant: two 1,900-hp (1417-kW) Daimler-Benz DB 603G inverted V-12 liquid-cooled piston engines in annular cowlings

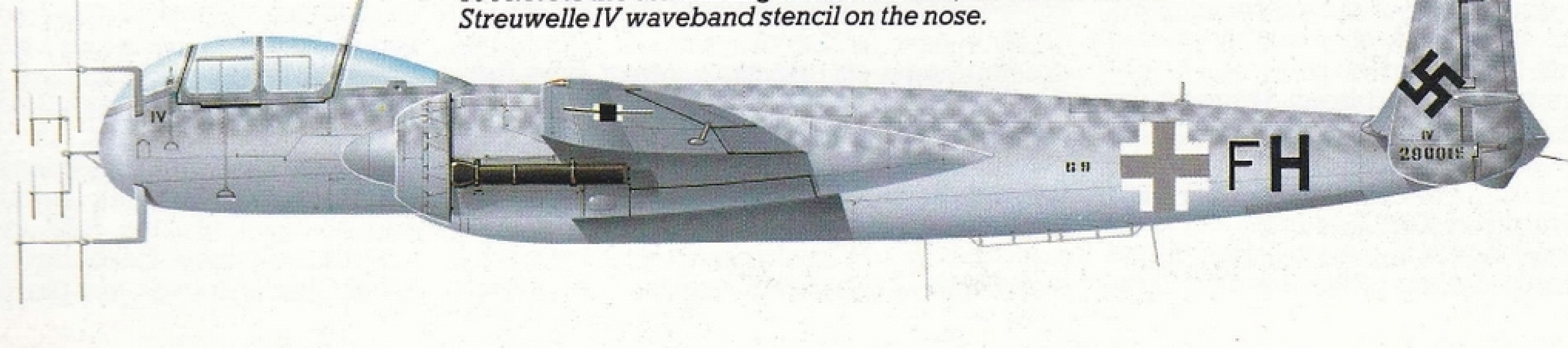
Performance: maximum speed 670 km/h (416 mph) at 7000 m (22,965 ft); initial climb rate 640 m (2,100 ft) per minute; service ceiling 12330 m (40,455 ft); normal range 1545 km (960 miles)

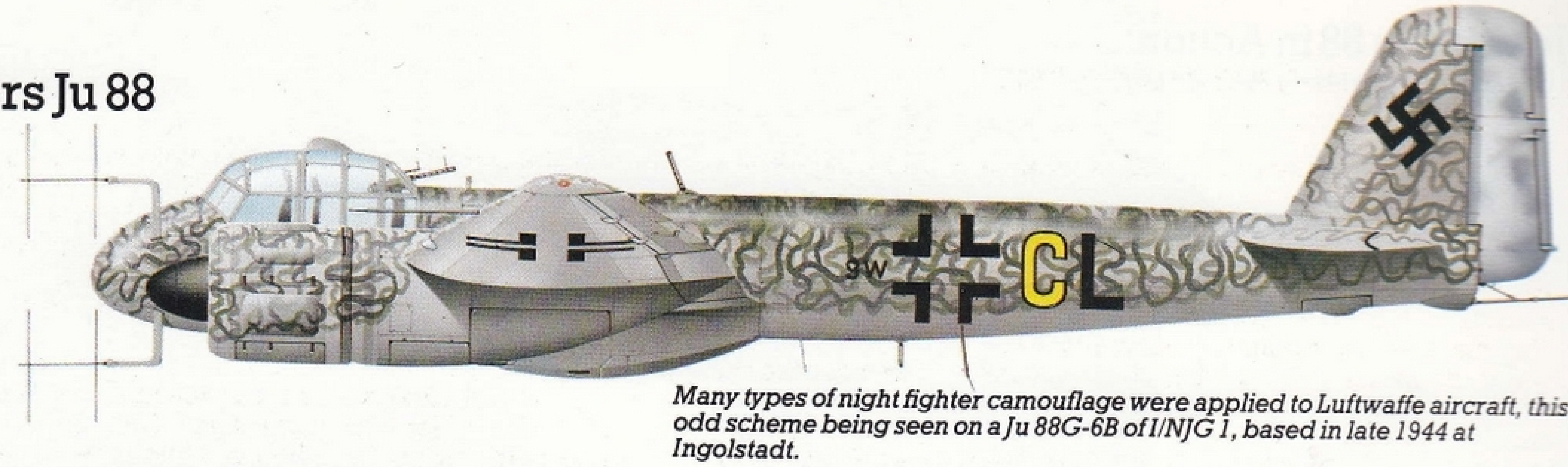
Weights: empty 11200 kg (24,691 lb); maximum take-off 15300 kg (33,730 lb)

Dimensions: span 18.50 m (60 ft 8½ in); length 15.54 m (50 ft 11¾ in); height 4.10 m (13 ft 5½ in); wing area 44.50 m^2 (479 sq ft)

Armament: two 30-mm MK 108 cannon in the wing roots, two 20-mm MK 103 and two 20-mm MG 151/20 cannon in ventral pack, all firing forward, and two 30-mm Mk 108 cannon in *schräge Musik* installation aft of the cockpit, firing obliquely forwards and upwards

G9+FH was an He 219A-5/R1 serving with NJG 1 during the hectic battles of 1944. Note the contrasting unit code sizes, the maker's serial on the fin and Streuwelle IV waveband stencil on the nose.





Many types of night fighter camouflage were applied to Luftwaffe aircraft, this odd scheme being seen on a Ju 88G-6B of I/NJG 1, based in late 1944 at Ingolstadt.

First employment of the **Junkers Ju 88** in the night fighting role was as an intruder during the late summer of 1940, when Ju 88C-2 *Zerstörer* (heavy fighters) of II/NJG 1 under Hauptmann Karl Heyse at Gilze Rijen began operating over British bomber bases in eastern England. Although other intruder versions followed (capable of carrying a bombload), the first dedicated night-fighter version was the FuG 202 Lichtenstein BC-equipped **Ju 88C-6b.** A derivative of this was the Ju 88R series which, in its Ju 88R-1 form with 1,600-hp (1193-kW) BMW 801MA or 801C engines, was otherwise similar to the Ju 88C-6; the **Ju 88R-2**, with 1,700-hp (1268-kW) BMW 801D engines, featured FuG 217 Neptun R tail-warning radar. Limited production of the Ju 88C and Ju 88R continued in 1942 and 1943 but, understandably perhaps, production priorities were accorded to the excellent bomber versions of the Ju 88 with the result that the Messerschmitt Bf 110 night-fighters far outnumbered other types during this period. The massive increase in the British bombing offensive in 1943, however, prompted the development of a new night-fighter version of the Ju 88, the **Ju 88G** series, and sub-variants of this gradually began to overshadow the Bf 110 in the last year of the war. Identified by the use of an enlarged, square fin (as used in the Ju 188), the first **Ju 88G-0** pre-production aircraft appeared early in 1944 powered by BMW 801Ds, equipped with Lichtenstein SN-2 radar and armed with four forward-firing 20-mm MG 151 cannon. There has been much confusion over the late models of Ju 88 night fighter, mainly because British writers for years believed the last operational models were G-7s. In fact the only types used in numbers were the Ju 88G-6a and 6b., built at Dessau and powered by BMW 801D engines, and the G-6c family built at Bernburg and powered by the Jumo 213E inverted V-12. Within these two great groups were numerous electronics fits, including the standard SN-2 radar and the later FuG 218 Neptun and FuG 240 Berlin. The Ju 88G-7 series had the long-span wing of the Ju 388 and only 12 were built (in November 1944), and used for test purposes. Some of the Luftwaffe's highest-scoring night-fighter pilots flew the Ju 88, including Helmut Lent who commanded NJG 3 (102 night victories), Heinz Rökker of 2./NJG 2 (62 victories) and Paul Zorner of II/NJG 100 (59 victories). A final act of defiance by the German *Nachtjagdverband* was staged on 3 March 1945, when about 100 night intruders and night-fighters managed to reach RAF Bomber Command's bases in England and shot down 22 heavy bombers; the British were ready on the following night, shooting down 20 German aircraft.

Specification

Ju 88G-6c

Type: three-seat night fighter
Powerplant: two 1,800-hp (1342-kW) Junkers Jumo 213E inverted V-12 liquid-cooled piston engines in annular cowlings with MW-50 water-methanol power boosting
Performance: maximum speed 625 km/h (388 mph) at 9000 m (29,530 ft); initial climb rate 500 m (1,640 ft) per minute; service ceiling 10000 m (32,810 ft); normal range 2250 km (1,398 miles)
Weights: empty 9965 kg (21,969 lb); maximum take-off 13100 kg (28,880 lb)
Dimensions: span 20.00 m (65 ft 7½ in); length 15.58 m (51 ft 1½ in); height 4.85 m (15 ft 11 in); wing area 54.50 m^2 (586.65 sq ft)
Armament: four forward-firing 20-mm MG 151/20 cannon in nose and two upward-firing 20-mm MG 151/20 in a midships *schräge Musik* installation

Junkers Ju 88 Night Fighter in Action

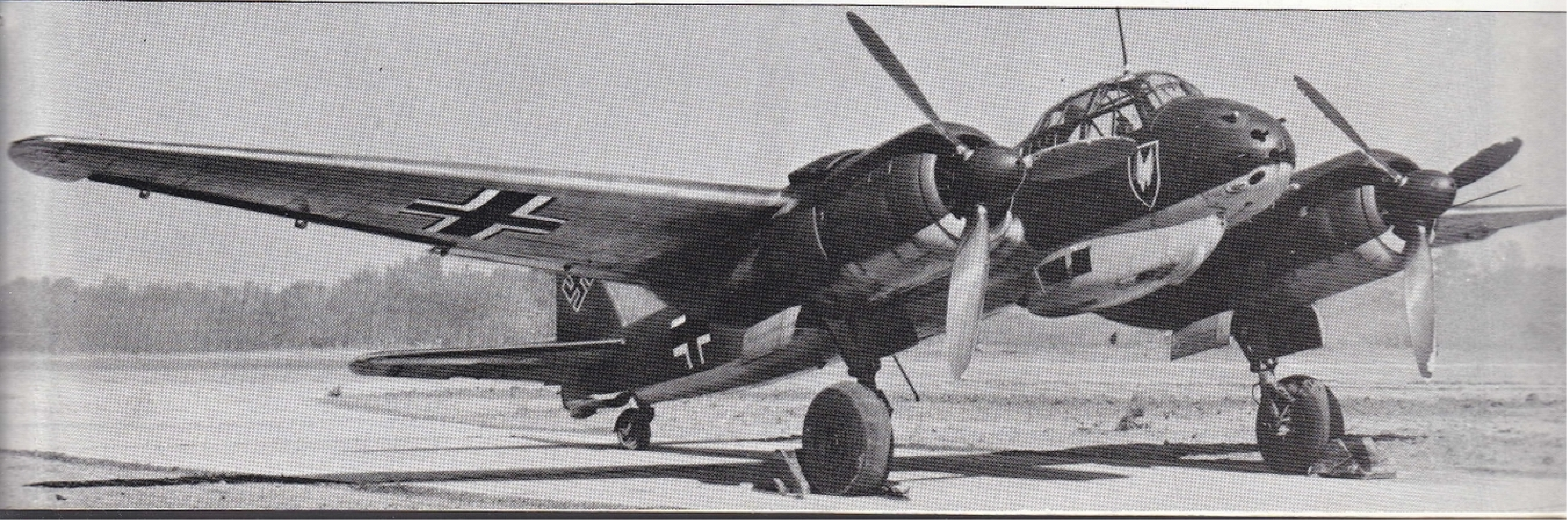
The Ju 88 was possibly the most versatile Axis aircraft of World War II, serving in almost every role on most fronts, and provided the backbone of the German night fighter force for most of the war. Not available in as great numbers as the Bf 110, or possessing the performance of the He 219, the Ju 88 was nevertheless probably responsible for the majority of night fighter kills.

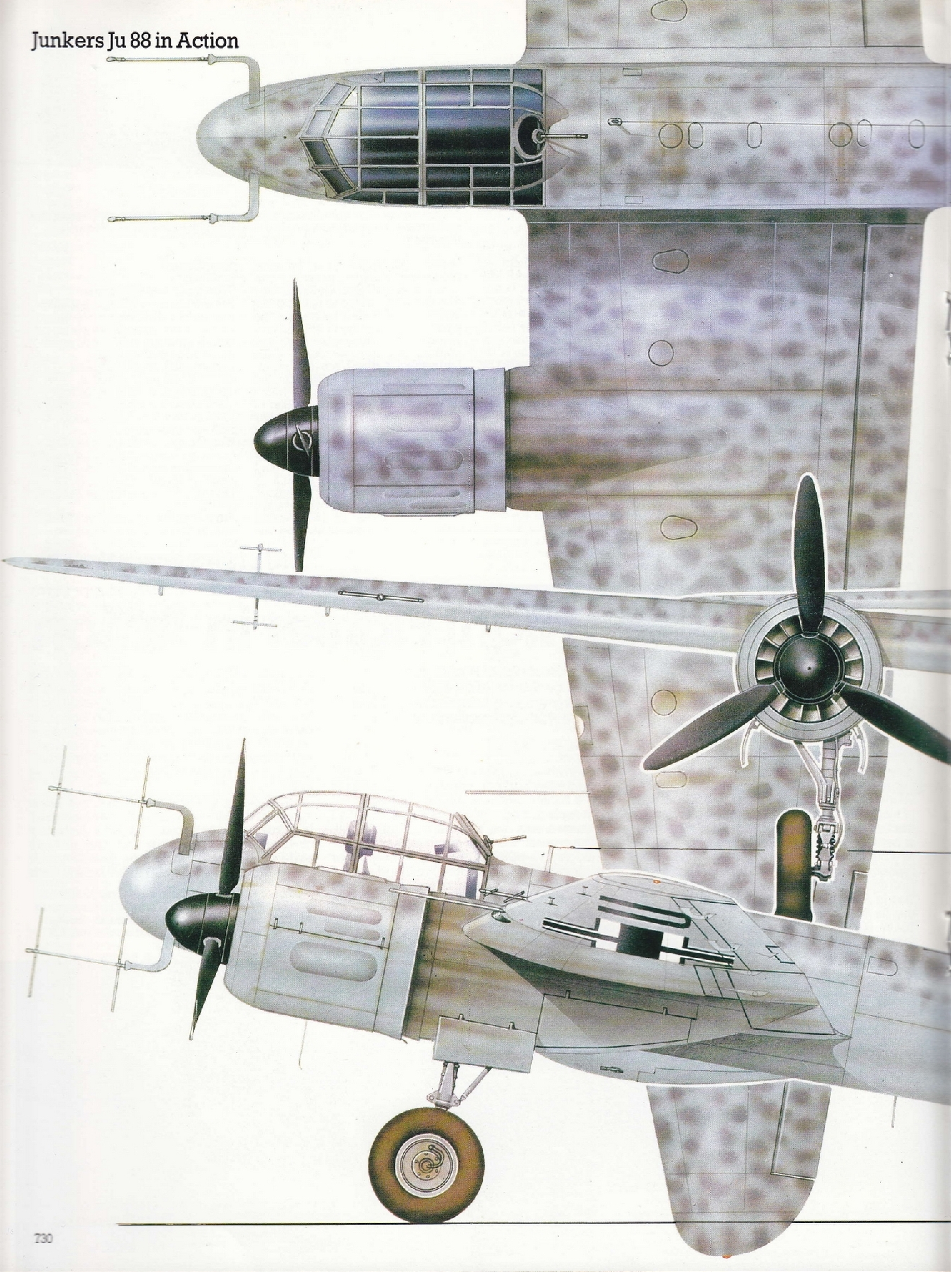
First flown in 1936 as a high-speed level and dive-bomber, the Junkers Ju 88 was just entering service with the Luftwaffe at the start of World War II. It was by far the newest and best of all the many twin-engine bombers used by the Luftwaffe in the early part of the war, and it is hardly surprising that it was soon proposed as a *Zerstörer* (destroyer, or long-range heavy fighter). The Ju 88 V7 prototype of such a version flew immediately before the start of the war in August 1939, and plans went ahead for the Ju 88C series of heavy fighters with the BMW 801 MA radial engine in place of the Jumo 211B-1 liquid-cooled engine with annular radiators.

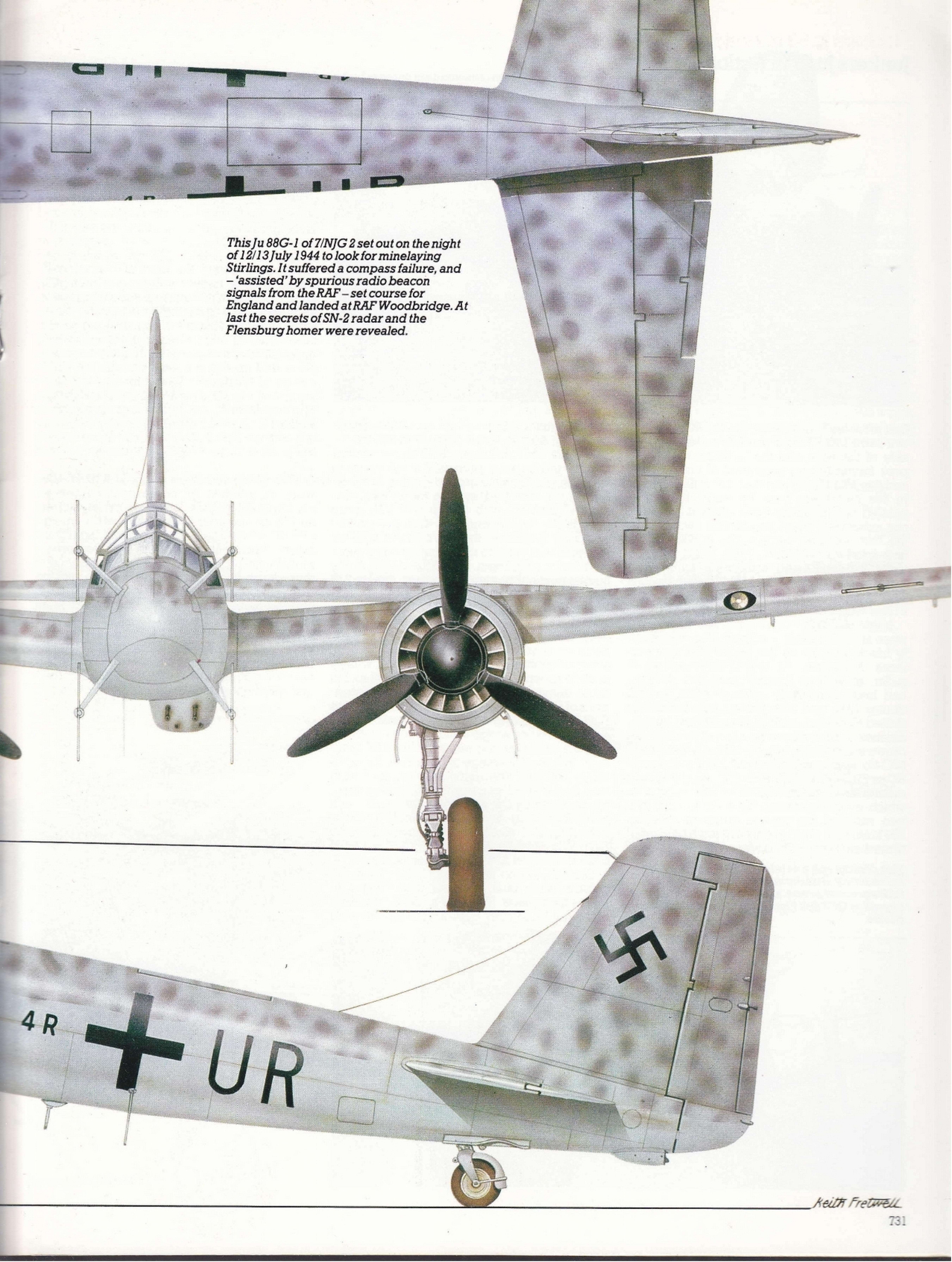
Meanwhile a number of Ju 88A-1s, the original short-span bomber, were converted into Ju 88 C-2 fighters with the glazed nose compartment replaced by a battery of two 20-mm MG FF cannon and two 7.92-mm (0.31-in) MG 17 machine-guns, the rear bomb bay being retained for 10 SC50 (50-kg/110-lb) bombs for intruder missions. This model retained its now unwanted dive brakes, and was intended for KG 30, but the start of major RAF night bombing of Germany on 15 May 1940 led to the hasty creation of the *Nachtjagd* (night-fighter force), and in July 1940 the new fighter Ju 88s were moved to II/NJG 1, which two months later was redesignated I/NJG 2. For more than a year this was the *Nachtjagd*'s only Ju 88 unit, made up of two *Staffeln* normally based at Gilze-Rijen and used almost exclusively on intruder missions over RAF bomber bases, as well as undertaking various research and evaluation programmes to try to devise better ways of fighting at night.

By 1942, by which time I/NJG 2 had been moved to the Mediterranean theatre, specially built Ju 88 versions became available. Naturally having the long-span wing and strengthened airframe, these comprised the Ju 88C-4 with Jumos and the Ju 88C-5 with BMW radials. Both

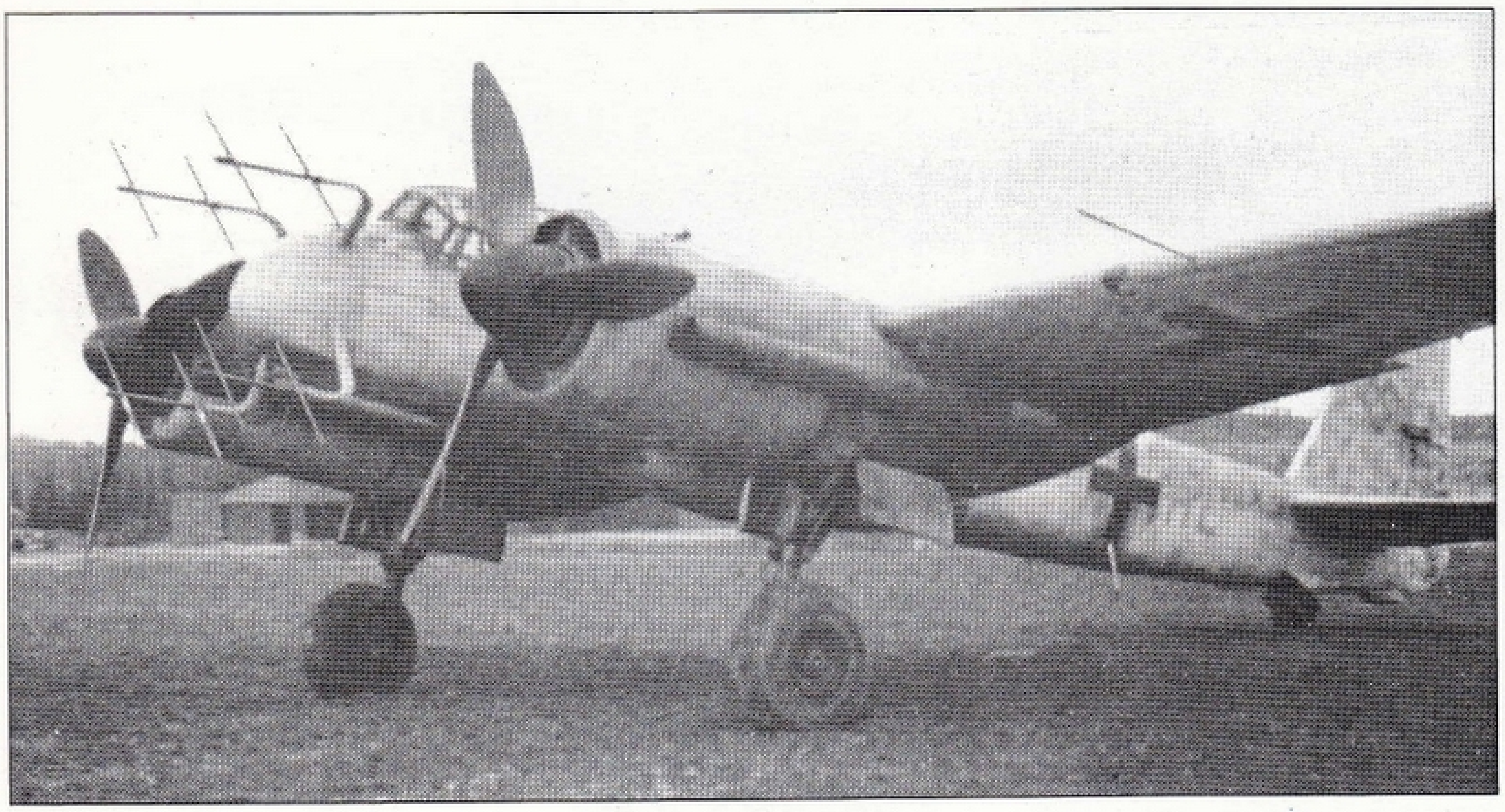
Built in 1943, this beautifully preserved Ju 88R-1 is in the RAF Battle of Britain Museum. It was flown to Aberdeen in mysterious circumstances – being escorted in by Spitfires sent to meet it – from NJG 3 in Norway on 9 May 1943.







This Ju 88G-1 of 7/NJG 2 set out on the night of 12/13 July 1944 to look for minelaying Stirlings. It suffered a compass failure, and – 'assisted' by spurious radio beacon signals from the RAF – set course for England and landed at RAF Woodbridge. At last the secrets of SN-2 radar and the Flensburg homer were revealed.



This Ju 88G-6 (not a G-7) is believed to have served with NJG 100, and is typical of the final batches, with sloping SN-2 aerials and paddle-blade propellers. Even today there is much mystery about the Ju 88G-7 series, which according to recent German writers hardly even reached the test centres.

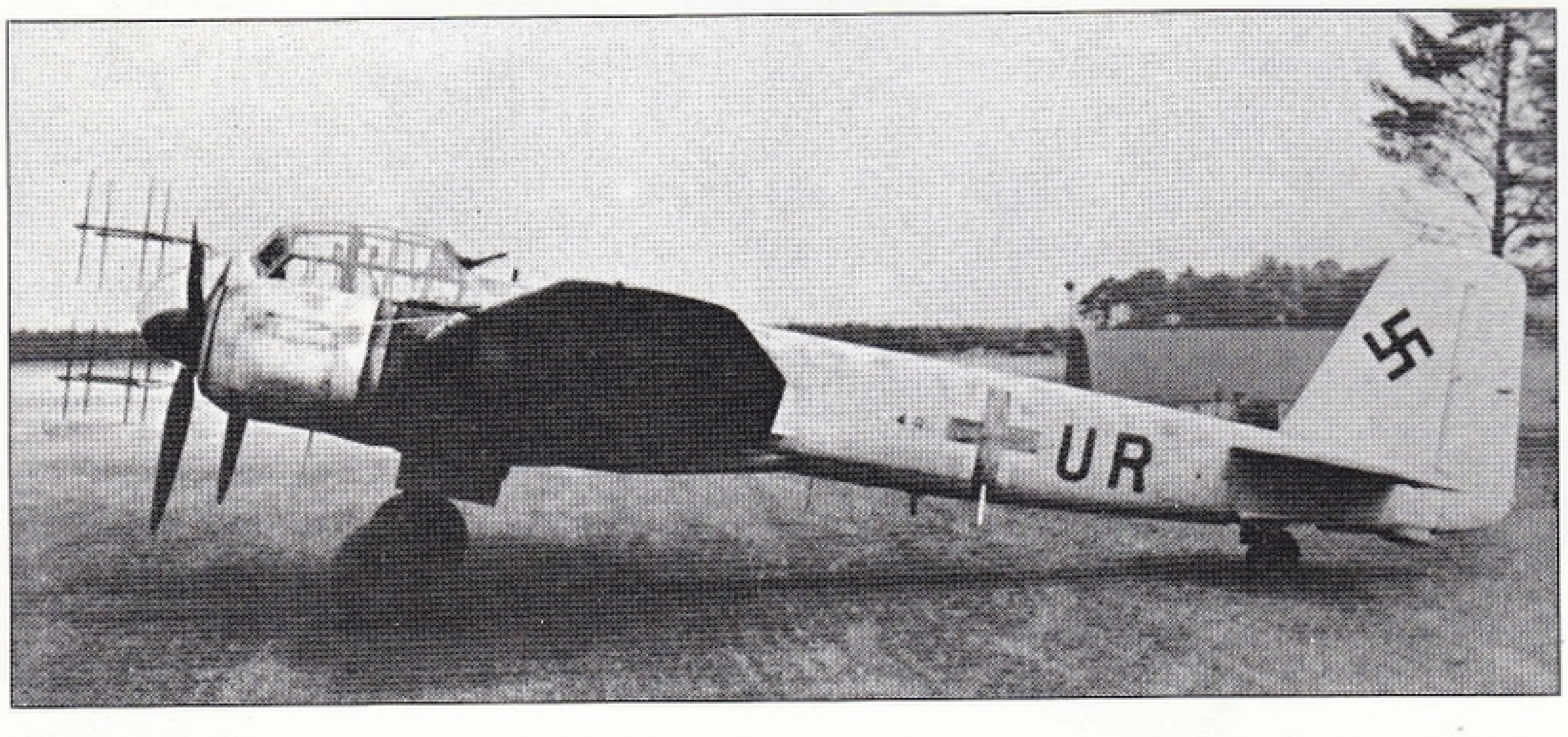
had increased armament, the Ju 88C-4 having two extra MG FFs in a gondola under the right side of the nose and the Ju 88C-5 the rather poor forward-firing armament of one MG FF and five MG 17s. Fewer than 100 of all C-series Ju 88s had been built by early 1942 (and painted in a haphazard collection of dark colour schemes), when production switched to the first definitive version, the Ju 88C-6. This had 1,420-hp (1050-kW) Jumo 211Js and the usual forward-firing armament comprised three MG FFs and three MG 17s, with various rear-firing defensive guns such as the twin MG 81Z or single MG 131.

It was basically a day *Zerstörer*, but the units were all NJG *Staffeln*, and the colour was usually black, at least on the upper and side surfaces. Moreover, AI (airborne interception) radar, as well as *Spanner* infra-red devices, had been intensively flown in other aircraft during 1941, and with the aid of a handful of skilled *Experten*, such as Helmut Lent, the resistance to such clever gadgets of ordinary air crews was being overcome. In early 1942 the Ju 88C-6b appeared with FuG 202 Lichtenstein BC or FuG 212 Lichtenstein C-1 radar adding a mass of small vertical dipole aerials on the nose which, even discounting the wing de-icing system, reduced the maker's brochure speed of 550 km/h (342 mph) to only 470 km/h (292 mph) at medium heights. This was universally held to be inadequate, and was the only serious shortcoming in an otherwise popular machine.

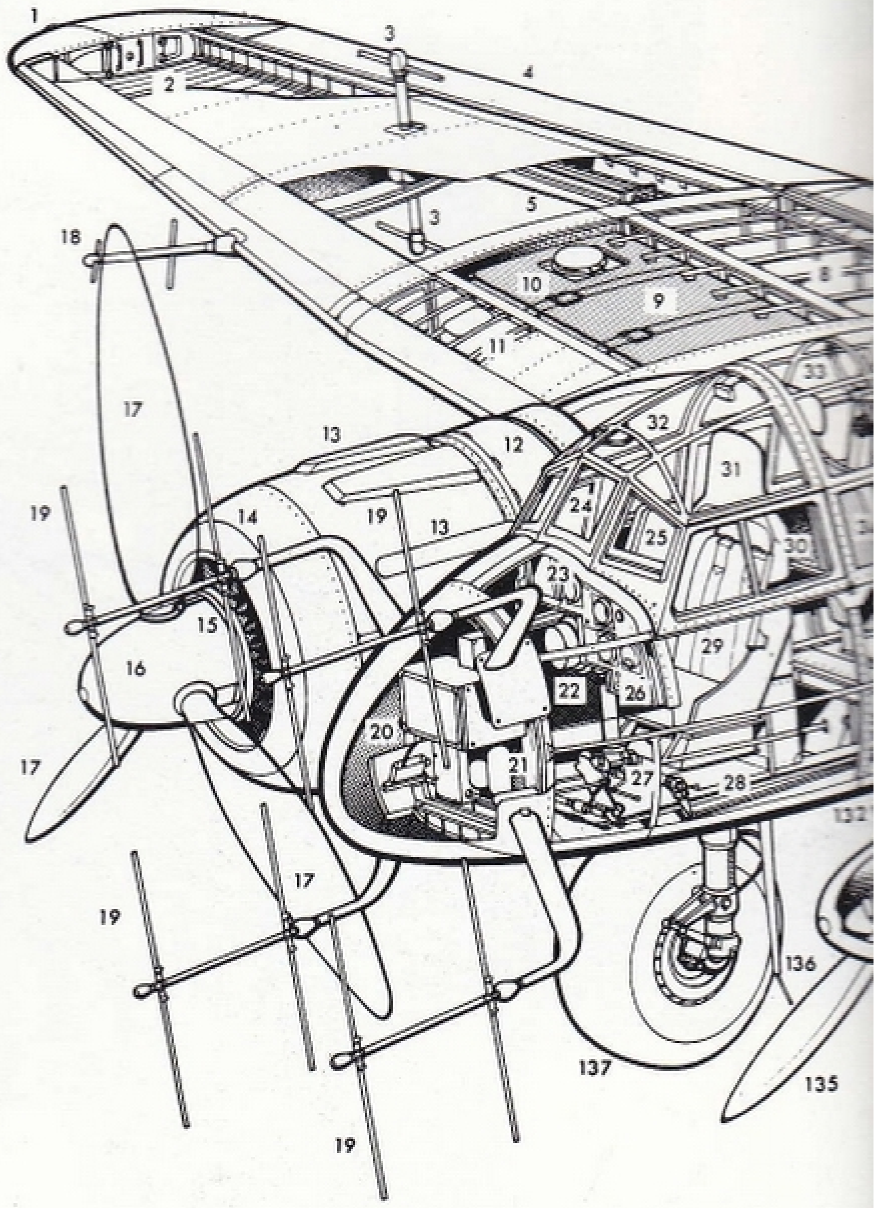
In early 1943, while the NJG force swelled rapidly and became proficient in intercepting RAF 'heavies' with the ground-guided *Himmelbett* (four-poster bed) system, the Ju 88R-1 also entered service, with 400 hp (298 kW) extra from BMW 801MA engines. This powerplant was very welcome, though it made stability marginal and to try to climb out on one engine often led to a fatal spin. Throughout 1943, while furious political battles raged over the He 219 and other later types, the Ju 88R remained the best all-round night-fighter, and it had the speed, endurance and weight-lifting capability to fly for seven hours and carry all the new devices that were being invented. Chief among the latter were FuG 350 Naxos Z, with its passive receiver mounted in the cockpit roof to home automatically on the beacon-like emissions of RAF H2S mapping radars, and later the FuG 227 Flensburg, with vertical dipole receivers on the outer wings, which homed on to the 'Monica'a tail-warning radars of the RAF bombers, the effective range of Flensburg being 62 miles (100 km). The marvel is that any British heavies escaped; as it was the NJG crews were overworked by the availability of targets, and such *Experten* as Major Heinz-Wolfgang Schnaufer (121 night victories), Major Prinz zu Sayn-Wittgenstein (83) and Helmut Lent (102) often destroyed five bombers in one night.

During 1943 no fewer than 706 Ju 88 night-fighters were built, and two major developments took place. The RAF's use of 'Window' metal-foil ECM over Hamburg in July spurred priority development of SN-2 radar, with *Hirschgeweih* (stag's antlers) nose aerials, and these gradually came into use at the end of the year. At first SN-2 ran out of good echoes at ranges around 2,450 ft (750 m), which forced the Ju 88 to retain the old FuG 212 as well, resulting in a heavy high-drag combination which occasionally caused severe vibration and, especially if coated with ice, interfered with the pilot's forward vision. The big advantage were its wide angular coverage, which enabled crews to select from many targets at once, and its ability to 'see' through the RAF's clouds of 'Window'. The other big development was the *schräge Musik* (jazz) installation of upward-firing guns. Such weapons had been studied from 1940, but only gradually came into use with the NJG *Staffeln* in 1942 and arrived on the Ju 88 with the Ju 88C-6c at the very end of 1943.

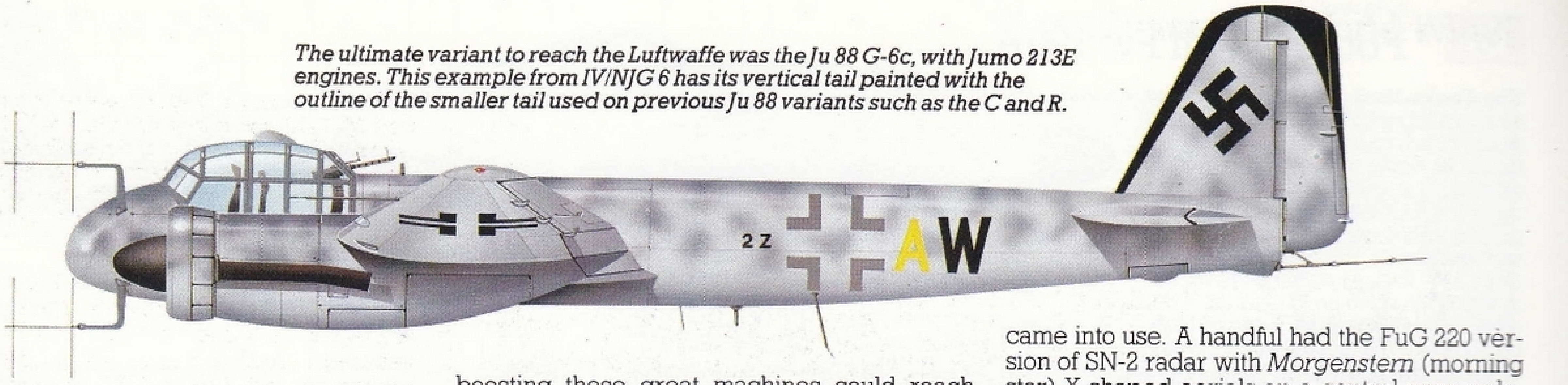
Two of the excellent 20-mm MG 151 guns were mounted at 70° in the centre fuselage, each with 200 rounds. It was normal for the pilot and flight engineer to search to left, right and above, while the radio operator searched astern. Thanks largely to the passive homers Flensburg and Naxos Z, there was seldom any difficulty in latching on to a bomber, and the main problem was that full power was often needed to bring the heavily burdened Ju 88 close beneath it. Real *Experten* could use their roof-mounted Revi C/12D sight in a perfect no-deflection shot from such short range that they could sever the enemy's wing spar with as few as 20 rounds, returning with the bomber's trailing aerial wrapped round the fighter's wing.



This photograph was taken at RAF Woodbridge immediately after the arrival there of one of the RAF's greatest prizes, a new Ju 88G-1 with full operative SN-2 and Flensburg radar and homing device.



© Pilot Press Limited



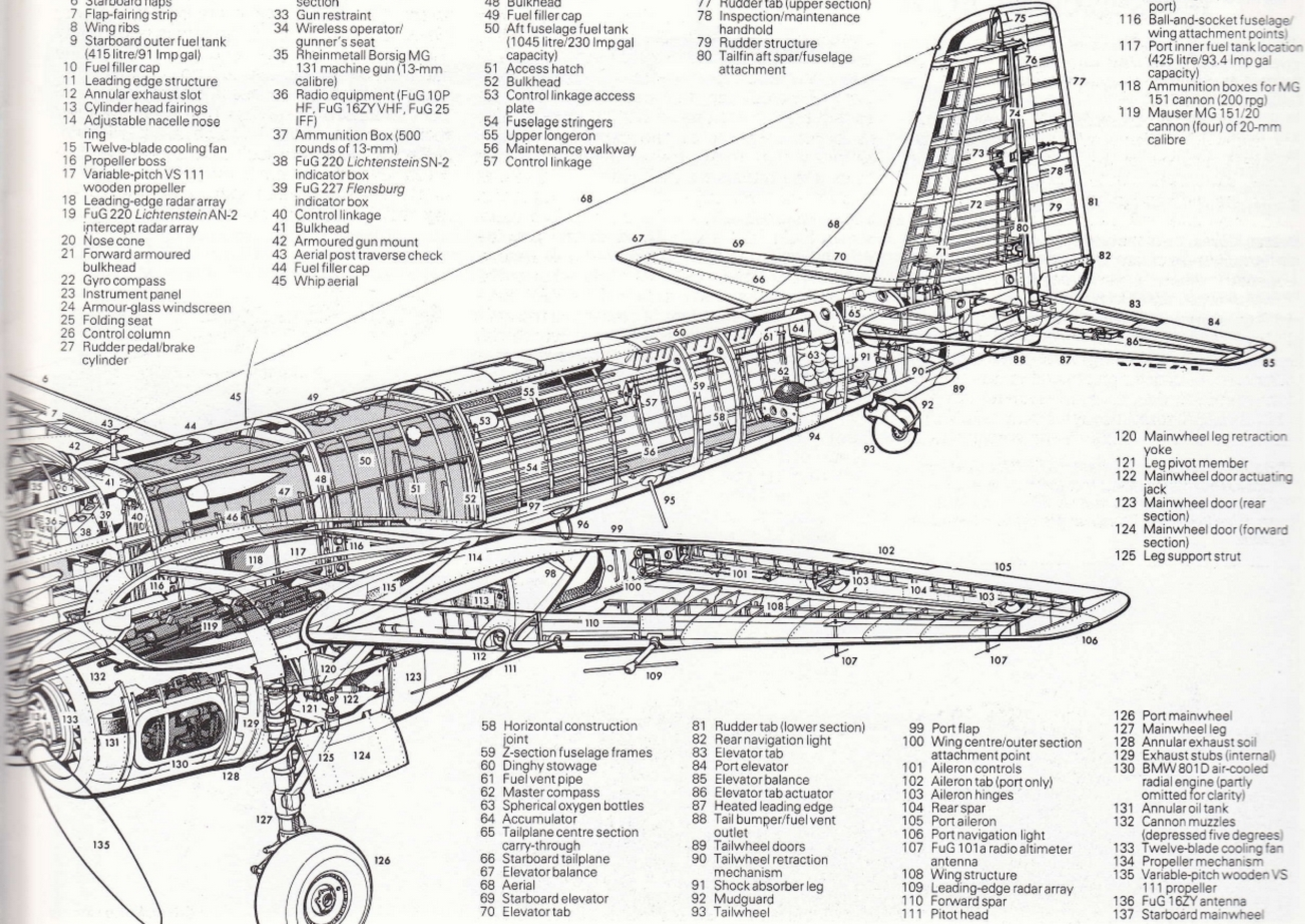
The ultimate variant to reach the Luftwaffe was the Ju 88 G-6c, with Jumo 213E engines. This example from IV/NJG 6 has its vertical tail painted with the outline of the smaller tail used on previous Ju 88 variants such as the C and R.

By 1944 RAF losses were very severe, but the sheer brilliance and sustained effort of the British ECM workers was taking its toll. SN-2 was soon being heavily jammed, as were the ground radio communications, while H2S 'Monica' were switched off. De Havilland Mosquitoes roamed the sky all over Germany each night, turning the hunters into the hunted. The one positive development was the Ju 88G, available from spring 1944, which initially had 1,700-hp (1268-kW) BMW 801D radials and later 1,750-hp (1305-kW) Jumo 213E liquid-cooled engines, and a big (Ju 188 type) tail giving good handling. With MW50 power boosting these great machines could reach 390 mph (628 km/h) at high altitude even with 13 items of avionics on board and a fourth man to add another pair of eyes. Production actually increased throughout 1944, while all other Ju 88s and *Zerstörers* stopped, to peak at 339 aircraft in November. By this time the highly effective FuG 351 Korfu homer was in use, together with the FuG 120 Bernhardine high-security jam-proof teleprinter.

III/NJG 3, II/NFG 6 and I/NJG 7 re-equipped with the Ju 88G-1 in June and July 1944, and by September the Ju 88G replaced virtually all other variants, and the Ju 88G-6a, Ju 88G-6b (both with BMWs) and Ju 88G-6c (Jumo 213) came into use. A handful had the FuG 220 version of SN-2 radar with *Morgenstern* (morning star) X-shaped aerials on a central nose pole. One was flown by the commander of II/NJG 5. A few *Experten*, such as the indestructible Major Schoenert who ended the war as *Kommodore* of NJG 5, had all the SN-2 aerials on rear-fuselage masts, with the tail-warning aerials projecting horizontally from the fin. Several Ju 88G-6s had the *Morgenstern* installation faired over by a wooden cone. The FuG 240 Berlin centrimetric radar was fitted to just one Ju 88G-6c, 3C+GB assigned to Stab/NJG 4 in April 1945. The long-span Ju 88G-7, with Ju 388 wings, was a Ju 88G-6c otherwise, but only about nine were flown and none reached an operational unit.

Junkers Ju 88G-1 cutaway drawing key

1 Starboard navigation light
2 Wingtip profile
3 FuG 227 'Flensburg' radar
4 Starboard aileron
5 Aileron control runs
6 Starboard flaps
7 Flap-fairing strip
8 Wing ribs
9 Starboard outer fuel tank (415 litre/91 Imp gal)
10 Fuel filler cap
11 Leading edge structure
12 Annular exhaust slot
13 Cylinder head fairings
14 Adjustable nacelle nose ring
15 Twelve-blade cooling fan
16 Propeller boss
17 Variable-pitch VS 111 wooden propeller
18 Leading-edge radar array
19 FuG 220 *Lichtenstein* AN-2 intercept radar array
20 Nose cone
21 Forward armoured bulkhead
22 Gyro compass
23 Instrument panel
24 Armour-glass windscreen
25 Folding seat
26 Control column
27 Rudder pedal/brake cylinder
28 Control runs
29 Pilot's armoured seat
30 Sliding window section
31 Headrest
32 Jettisonable canopy roof section
33 Gun restraint
34 Wireless operator/gunner's seat
35 Rheinmetall Borsig MG 131 machine gun (13-mm calibre)
36 Radio equipment (FuG 10P HF, FuG 16ZY VHF, FuG 25 IFF)
37 Ammunition Box (500 rounds of 13-mm)
38 FuG 220 *Lichtenstein* SN-2 indicator box
39 FuG 227 *Flensburg* indicator box
40 Control linkage
41 Bulkhead
42 Armoured gun mount
43 Aerial post traverse check
44 Fuel filler cap
45 Whip aerial
46 Forward fuselage fuel tank (480 litre/105 Imp gal capacity)
47 Fuselage horizontal construction joint
48 Bulkhead
49 Fuel filler cap
50 Aft fuselage fuel tank (1045 litre/230 Imp gal capacity)
51 Access hatch
52 Bulkhead
53 Control linkage access plate
54 Fuselage stringers
55 Upper longeron
56 Maintenance walkway
57 Control linkage
71 Tailfin forward spar/fuselage attachment
72 Tailfin structure
73 Rudder actuator
74 Rudder post
75 Rudder mass balance
76 Rudder upper hinge
77 Rudder tab (upper section)
78 Inspection/maintenance handhold
79 Rudder structure
80 Tailfin aft spar/fuselage attachment
94 Access hatch
95 Fixed antenna
96 D/F loop
97 Lower longeron
98 Nacelle/flap fairing
112 Landing lamp
113 Mainwheel well rear bulkhead
114 Port outer fuel tank location (415 litre/91 Imp gal capacity)
115 Ventral gun pack (offset to port)
116 Ball-and-socket fuselage/wing attachment points)
117 Port inner fuel tank location (425 litre/93.4 Imp gal capacity)
118 Ammunition boxes for MG 151 cannon (200 rpg)
119 Mauser MG 151/20 cannon (four) of 20-mm calibre

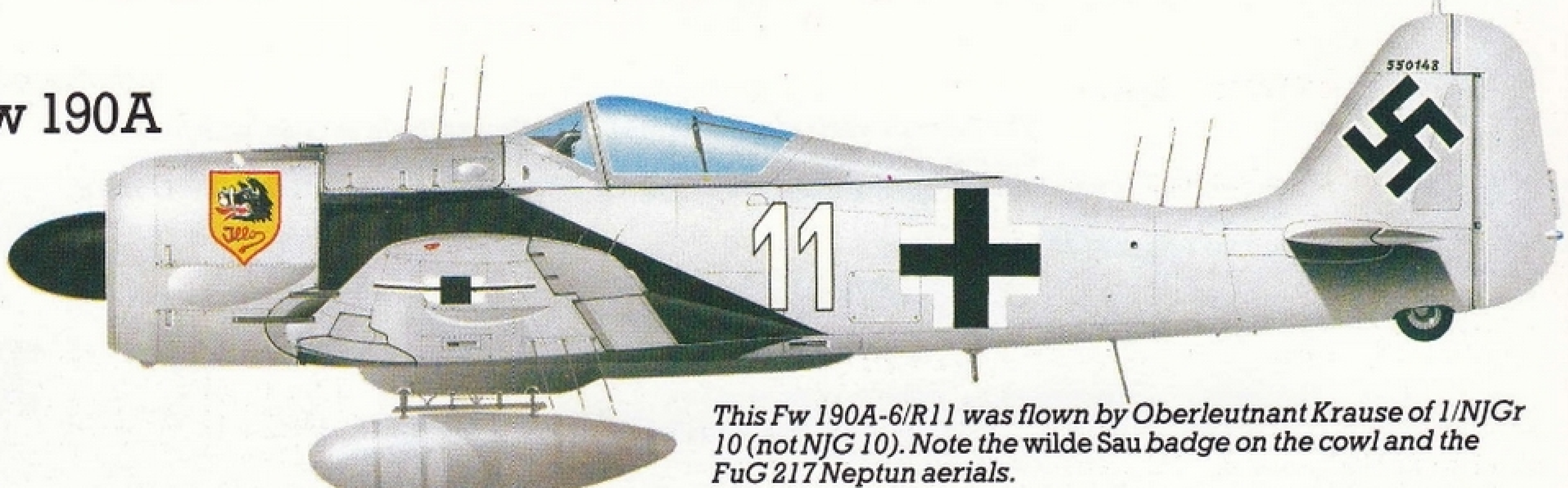


120 Mainwheel leg retraction yoke
121 Leg pivot member
122 Mainwheel door actuating jack
123 Mainwheel door (rear section)
124 Mainwheel door (forward section)
125 Leg support strut

58 Horizontal construction joint
59 Z-section fuselage frames
60 Dinghy stowage
61 Fuel vent pipe
62 Master compass
63 Spherical oxygen bottles
64 Accumulator
65 Tailplane centre section carry-through
66 Starboard tailplane
67 Elevator balance
68 Aerial
69 Starboard elevator
70 Elevator tab
81 Rudder tab (lower section)
82 Rear navigation light
83 Elevator tab
84 Port elevator
85 Elevator balance
86 Elevator tab actuator
87 Heated leading edge
88 Tail bumper/fuel vent outlet
89 Tailwheel doors
90 Tailwheel retraction mechanism
91 Shock absorber leg
92 Mudguard
93 Tailwheel
99 Port flap
100 Wing centre/outer section attachment point
101 Aileron controls
102 Aileron tab (port only)
103 Aileron hinges
104 Rear spar
105 Port aileron
106 Port navigation light
107 FuG 101a radio altimeter antenna
108 Wing structure
109 Leading-edge radar array
110 Forward spar
111 Pitot head
126 Port mainwheel
127 Mainwheel leg
128 Annular exhaust soil
129 Exhaust stubs (internal)
130 BMW 801D air-cooled radial engine (partly omitted for clarity)
131 Annular oil tank
132 Cannon muzzles (depressed five degrees)
133 Twelve-blade cooling fan
134 Propeller mechanism
135 Variable-pitch wooden VS 111 propeller
136 FuG 16ZY antenna
137 Starboard mainwheel

GERMANY

Focke-Wulf Fw 190A



This Fw 190A-6/R11 was flown by Oberleutnant Krause of 1/NJGr 10 (not NJG 10). Note the wilde Sau *badge on the cowl and the FuG 217 Neptun aerials.*

The **Focke-Wulf Fw 190** was never strictly a night-fighter in the accepted sense of being designed or modified for night fighting yet, on account of operational circumstances forced upon the Luftwaffe, came to be employed under certain conditions very successfully in the night battle over Germany. Following the introduction of 'Window' jamming of German radar at the beginning of the Battle of Hamburg, which caused major dislocation of the *Himmelbett* (four-poster bed) defence system, a distinguished German bomber pilot, Major Hajo Herrmann, suggested employing day fighters at night, particularly when RAF jamming threatened paralysis of the radar control of night-fighters. Accordingly a special unit (codenamed *wilde Sau*, or 'wild boar' to differentiate its tactics from *zahme Sau* or 'tame boar' tactics, which embraced night-fighters operating under radar control) was formed as Jagdgeschwader 300, under Herrmann himself; based principally in north and west Germany, the *Geschwaderstab* and II/JG 300 flew **Fw 190A-5/U2** fighters while I and III/JG 300 flew Messerschmitt Bf 109Gs at the outset. In its first major night operation, during the RAF attack on Peenemünde on 17/18 August 1943, JG 300 failed to make contact when bombing feints suggested that Berlin was the target. However, during the next month the *wilde Sau* tactics paid handsome dividends, and Herrmann was acclaimed a national hero, and promoted Oberstleutnant as commander of a much expanded Jagddivision 30, comprising JG 300, now commanded by Oberstleutnant Kurt Kettner, JG 301 under Helmut Weinrich at Neubiberg and JG 302 at Doberitz under Major Ewald Janssen. Henceforth *wilde Sau* tactics were employed on any moonlit night, and on any other occasion over the target where the light of the ground fires silhouetted the bombers. Winter flying conditions curtailed the operations severely, as did the wear on the aircraft themselves, of which Fw 190A-5 and **Fw 190A-8** fighters came to outnumber the Bf 109. Among the most succesful of the *wilde Sau* pilots were Konrad Bauer (*Staffelkapitän* of 5./JG 300 with 32 night victories), Kurt Welter (JG 301 with 29 victories), Friedrich-Karl Müller (JG 300's technical officer with 23 victories) and Walter Loos (of Stab JG 300 with 22 victories); Hajo Herrmann himself destroyed nine RAF bombers in the course of 50 sorties while Iro Ilk, *Gruppenkommandeur* of III/JG 300, shot down four Avro Lancasters in one night during April 1944.

Specification
Fw 190A-8

Type: single-seat day/night fighter

Powerplant: one 1,700-hp (1268-kW) BMW 801Dg 14-cylinder air-cooled radial piston engine with GM-1 nitrous oxide power boosting

Performance: maximum speed 655 km/h (407 mph) at 6000 m (19,685 ft); initial climb rate 720 m (2,360 ft) per minute; service ceiling 11400 m (37,400 ft); normal range 800 km (497 miles)

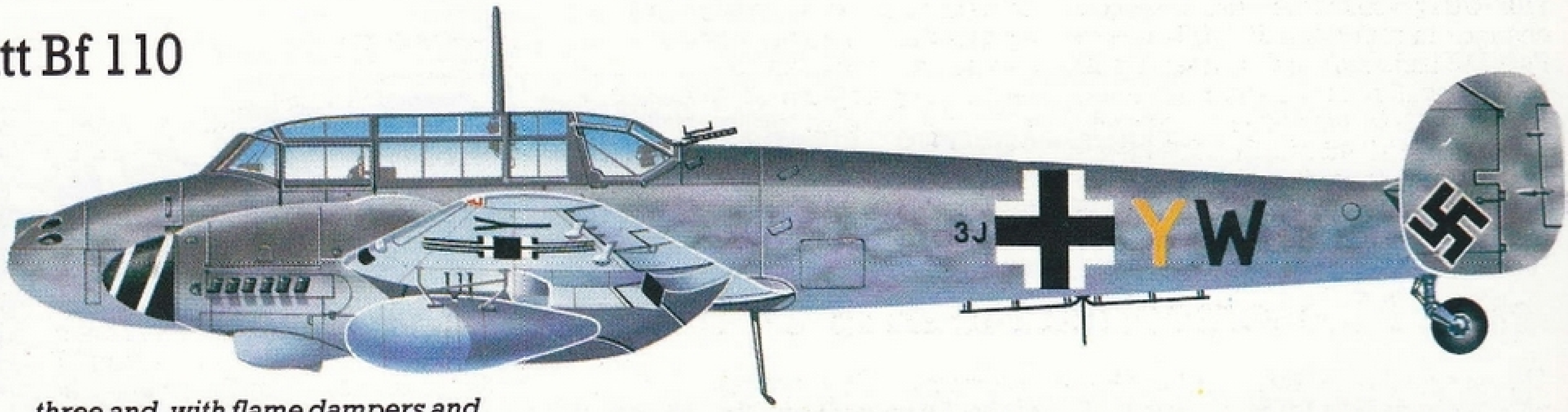
Weights: empty 3170 kg (6,989 lb); maximum take-off 4430 kg (9,766 lb)

Dimensions: span 34 ft 5½ in (10.50 m); length 8.80 m (28 ft 10½ in); height 3.95 m (13 ft 0 in); wing area 18.30 m^2 (196.98 sq ft)

Armament: two 20-mm MG 151/20 cannon in wing roots, two 30-mm MG 108 cannon in outer wings and two 13-mm (0.51-in) MG 131 heavy machine-guns on nose, all firing forward

GERMANY

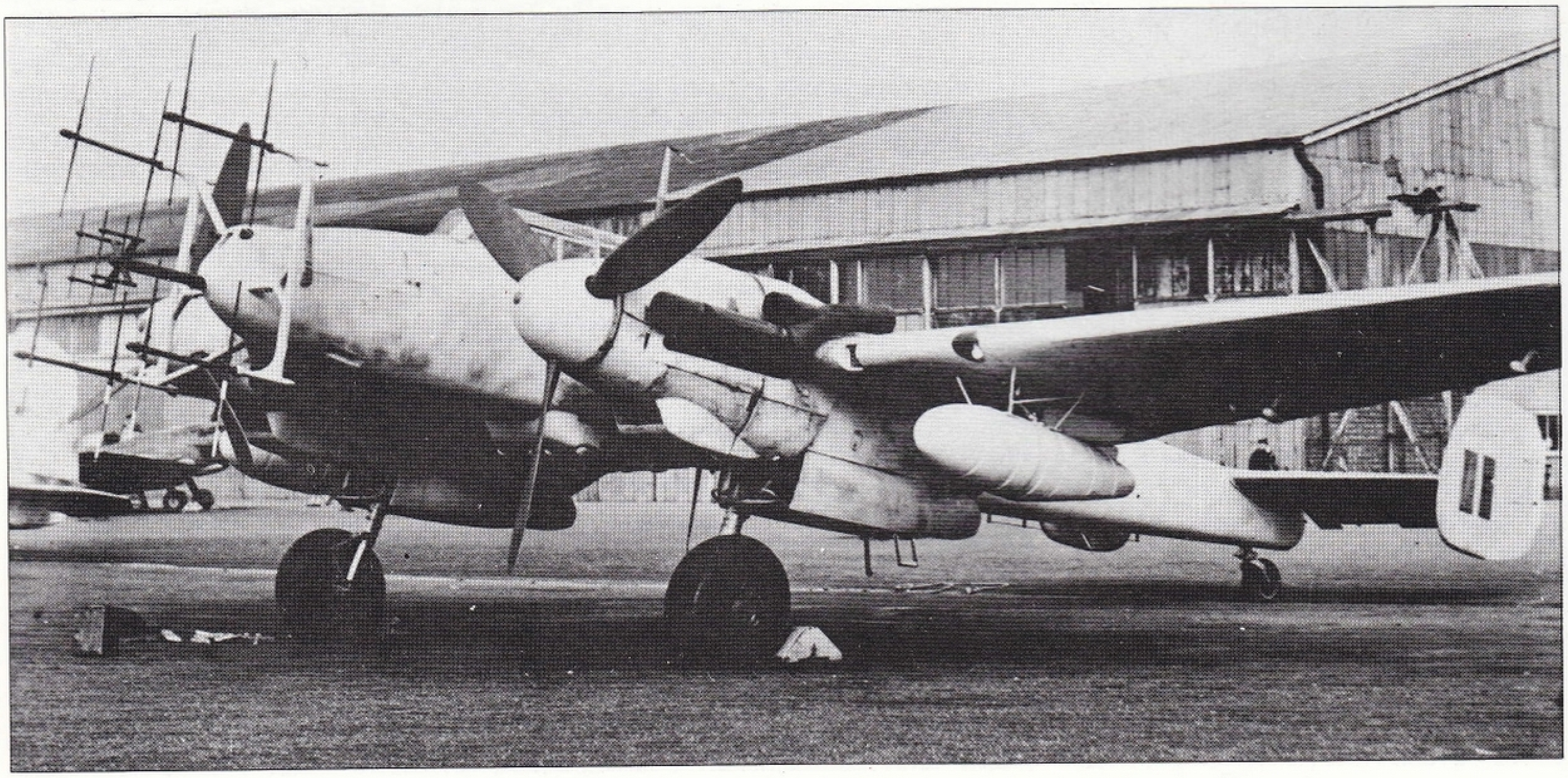
Messerschmitt Bf 110



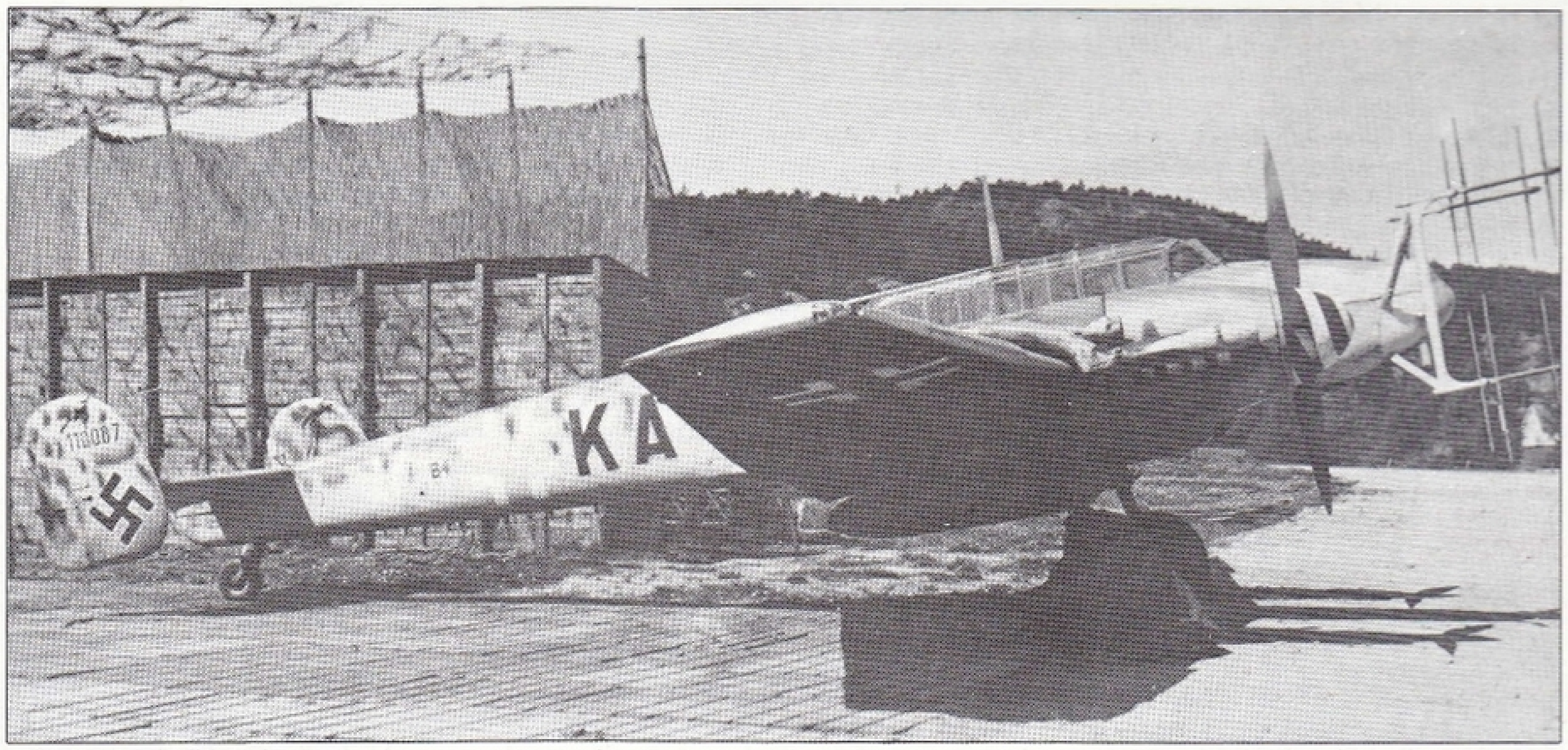
Above: Though fitted with enlarged fins and DB 605A engines, the early Bf 110G models lacked flame-damped exhausts, and this Bf 110G-2 of 12/NJG 3 had no radar. It was based at Stavanger until the final collapse in May 1945.

After proving something of a disappointment as a daylight 'heavy fighter' in the first year of the war (although continuing in that role to a lesser extent), the **Messerschmitt Bf 110** became numerically Germany's most important night-fighter, being selected from the outset in mid-1940 to provide the basic equipment of Josef Kammhüber's *Nachtjagdverband*,

Below: Most aerodynamically cluttered of all Bf 110 versions, the Bf 110G-4b/R3 had both SN-2 and C-1 radars, usually carried a crew of three and, with flame dampers and drop tanks as shown, had a maximum speed of typically 465 km/h (289 mph), barely faster than a Lancaster.



Seen serving with the NJ Staffel Norway at the end of the war, the Bf 110G-4c/R3 was almost the last version built. By 1944 the problems with the SN-2 radar at short ranges had been overcome, and the C-1 set could be eliminated.



formed on 20 July that year. At first standard **Bf 110C-2** and **Bf 110D-1** aircraft were used, these equipping I Gruppe, Nachtjagdgeschwader 1 (previously I/ZG 1) under Hauptmann Günther Radusch, but they were soon replaced by the first dedicated night-fighter version, the **Bf 110F-4** with 1,300-hp (969-kW) Daimler-Benz DB 601E engines, this version remaining in service, alongside later types, until the last year of the war. Within a year five *Nachtjagdgruppen* had been formed, four of them flying Bf 110s. The next night-fighter derivative, the **Bf 110G** series, was the principal version, usually powered by 1,475-hp (1100-kW) DB 605B engines. The **Bf 110G-4** possessed a basic armament of two 20-mm MG 151 cannon and four 7.92-mm (0.31-in) MG 17 machine-guns, but this was varied by numerous *Rüstsatz* field kits, of which the R8 introduced the *schräge Musik* twin upward-firing cannon in 1943 (also fitted in the **Bf 110F-4/U1**); suffix letters also identified changes in radar, the **Bf 110G-4a** with FuG 212 Lichtenstein C-1 radar, the **Bf 110G-4B** with both C-1 and SN-2 radar, the **Bf 110G-4c** with SN-2 radar only, and the **Bf 110G-4d** with FuG 227 Flensburg homing radar (tuned to the British 'Monica' tail-warning radar). There was also considerable work done with water-methanol and nitrous oxide injection in efforts to boost the performance of the Bf 110 and, although such improvements were only marginal, the aircraft remained in production almost up to the last months of the war. However, constant use of the night-fighters to assist in daylight defence against the American bomber offensive did much to prevent a much greater build-up of the night-fighter force, which nevertheless grew from 389 aircraft at the end of 1942 to 913 aircraft two years later. Only when the Messerschmitt Me 410 replaced the Bf 110 in service with the *Zerstörergeschwader* in 1944 were virtually all Bf 110Gs allocated to the *Nachtjagdverband*. Even then priority was given to the new Junkers Ju 88G and Heinkel He 219 night-fighters, so by the end of 1944 only about 150 Bf 110 night-fighters remained in service.

Specification

Bf 110G-4b/R3

Type: two-seat night-fighter

Powerplant: two 1,475-hp (1100-kW) Daimler-Benz DB 605B-1 inverted V-12 liquid-cooled piston engines

Performance: maximum speed 550 km/h (342 mph) at 7000 m (22,950 ft); climb to 5500 m (18,045 ft) in 8 minutes 6 seconds; service ceiling 8000 m (26,245 ft); maximum range 2100 km (1,305 miles)

Weights: empty 5100 kg (11,243 lb); maximum take-off 9900 kg (21,825 lb)

Dimensions: span 16.27 m (53 ft 4¾ in); length 12.65 m (41 ft 6¼ in); height 13 ft 1½ in (4.00 m); wing area 38.40 m^2 (413.33 sq ft)

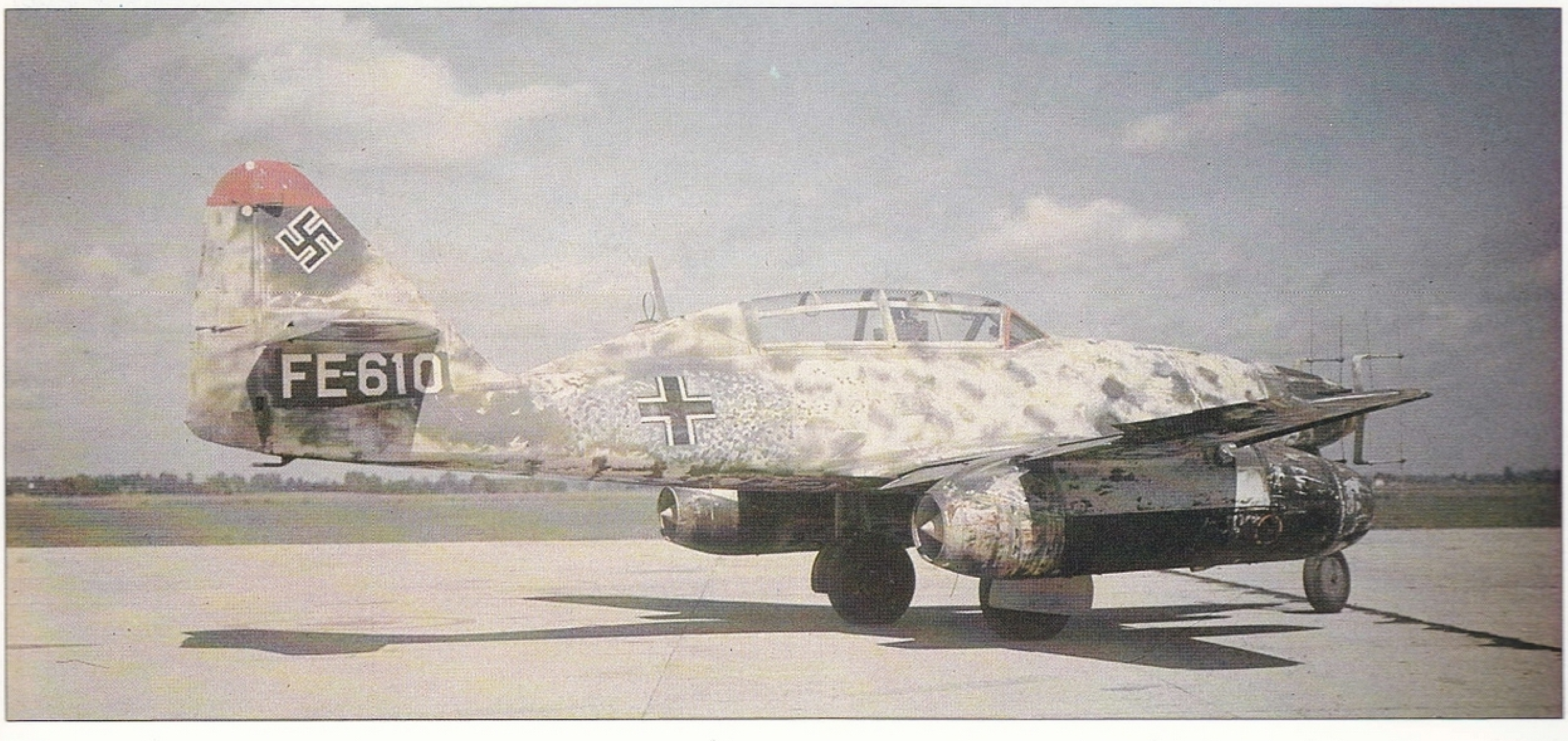
Armament: two 30-mm MK 108 and two 20-mm MG 151/20 cannon in the nose, and two 7.92-mm (0.31-in) MG 15 machine-guns in rear cockpit (MG 81Z installation)

GERMANY

Messerschmitt Me 262B-1a/U1

The fast declining ability of the German night-fighter force to halt RAF Bomber Command's offensve in the latter half of 1944 (when it was resumed after the Normandy invasion) prompted Oberst Hajo Herrmann, well known for his advocacy of drastic fighting tactics and commander of Jagddivision 30, to suggest adaptation of the **Messerschmitt Me 262** jet aircraft as a night-fighter; both he and Oberleutnant Behrens of the E-Stelle Rechlin tested an Me 262 experimentally fitted with Lichtenstein SN-2 radar and pronounced it a potentially excellent night-fighter. It was therefore proposed to undertake conversion of **Me 262B-1a** two-seat trainers as night-fighters, installing a formidable collection of radar and radio equipment, including FuG 16ZY VHF radio, FuG 25a IFF, FuG 120a Bernadine visual read-out repeater, FuG 125, FuG 218 Neptun V search radar and FuG 350ZC Naxos radar homer; the use of an ungainly 'toasting fork' aerial array on the nose reduced the Me 262's maximum speed from 873 km/h (542 mph) to 813 km/h (505 mph), but the ultimate production version, the **Me 262B-2a**, was intended

All the Luftwaffe aircraft which went to the USA in 1945-6 were badly repainted with incorrect markings, the* Hakenkreuz *and in this case the Iron Cross being pre-1938 style, too early for this Me 262B-1a/U1.



to incorporate a rear fuselage extended by 114 cm (45 in) to accommodate approximately 910 litres (200 Imp gal) of additional fuel. A pair of upward-firing 30-mm MK 108 cannon was mounted in a *schräge Musik* installation. Only one example of this version was flown before the end of the war, although a second aircraft which, equipped with centimetric AI radar in a blunt nose fairing and so dispensing with the ungainly external aerial array, was awaiting flight test when the war ended; it was expected to possess a top speed of 860 km/h (534 mph).

In terms of performance, if not equipment, these aircraft were far in advance of Allied night-fighters, and had they existed in service in significant numbers (and had Germany possessed the fuel to operate them) they must have inflicted prohibitive losses upon Bomber Command. As it was, one experimental unit, Kommando Stamp (under Major Gerhard Stamp, previously of I/JG 300, a *wilde Sau* unit) flew about 10 **Me 262B-1a/U1** fighters, the unit later being redesignated Kommando Welter under Oberleutnant Kurt Welter and deployed for the night defence of Berlin in March 1945; Welter himself is said to have shot down about 20 Allied aircraft at night in Me 262s in the last eight weeks of the war, and probably remains the world's most successful night-fighter jet pilot to this day.

Specification
Me 262B-1a/U1

Type: two-seat night-fighter
Powerplant: two 900-kg (1,984-lb) thrust Junkers Jumo 109-004B-1 axial-flow turbojets
Performance: maximum speed 813 km/h (505 mph) at 6000 m (19,685 ft); climb to 6000 m (19,685 ft) in 6 minutes 54 seconds; service ceiling 10850 m (35,600 ft); normal range 1050 km (652 miles)
Weights: empty about 4585 kg (10,110 lb); maximum take-off about 6585 kg (14,515 lb)
Dimensions: span 12.48 m (40 ft 11½ in); length 11.53 (37 ft 10 in); height 3.84 m (12 ft 7 in); wing area 21.70 m^2 (233.6 sq ft)
Armament: four forward-firing 30-mm MK 108 cannon in fuselage nose with a total of 360 rounds

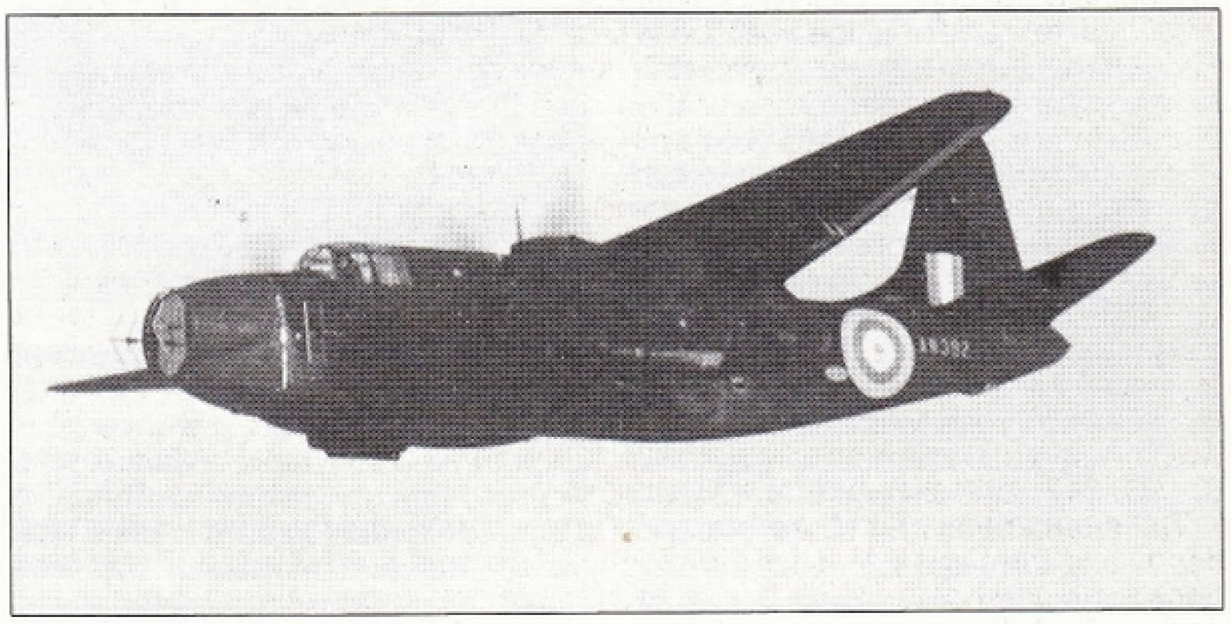
---

USA

Douglas P-70 Havoc

It is tempting to reason that it was on account of the USA's preoccupation with daylight bombing that the creation of a night-fighter force to counter any other nation's night bombing was regarded as superfluous. Whether such is even partly accurate or not, the fact remains that the USAAF possessed no dedicated night-fighter in service at the time of Pearl Harbor. Instead it was the British who first exploited the **Douglas A-20** as a night-fighter, converting about one hundred **Boston Mk II** light bomber variants to that role during the winter of 1940-1 by fitting an armament of eight machine-guns and AI Mk IV radar in the nose, flame-damping engine exhaust pipes and additional armour. Known as the **Havoc** in RAF service, this night-fighter first equipped No. 23 Squadron and was also involved in the lengthy Turbinlite (airborne searchlight) night fighting tactic, an almost worthless experiment that lasted about 18 months and occupied the efforts of no fewer than 10 squadrons. Another abortive RAF experiment involving Havocs was the 'Pandora' project, about 20 aircraft (eventually designated Havoc Mk III) being modified to trail the 'Long Aerial Mine' in the path of enemy bomber streams.

When eventually faced with sporadic night air attacks by the Japanese in the Western Pacific in 1942, the Americans decided to modify the A-20 as an interim night-fighter (pending the arrival of the P-61 in service), the first example originally produced for the USAAF undergoing conversion to feature a pair of 1,600-hp (1194-kW) Wright R-2600-11 radials, AI radar in a 'solid' nose and an armament of four 20-mm cannon in a pack under the fuselage. Some 39 **P-70A-1** night-fighters followed in 1943, in which the ventral guns were usually replaced by six 12.7-mm (0.5-in) guns in the nose, as well as a pair of hand-held guns in the rear cockpit; 65 conversions from A-20Gs produced the **P-70A-2**, similar to the P-70A-1 but without the rear guns. Most of these night-fighters were delivered to the squadrons of the 18th Fighter Group, commanded by Colonels Charles R. Greening and Robert A. Zaiser, which flew from Guadalcanal, supported American forces on Bougainville and flew night patrols over US bases in the Solomons. This was the only group to fly the P-70 extensively on operations. The final version was the **P-70B-2** night-fighter trainer, of which 105 were converted from A-20Gs and A-20Js to feature American SCR-720 and SCR-729 radar. These served with the 50th Fighter Group at Alachua Army Air Field, Florida, under Colonel Robert S. Quinn as a night-fighter crew training group before moving to the UK in 1944 as a fighter-bomber unit flying Republic P-47s. With the arrival of the P-61 in service in 1944, P-70As were distributed among the USAAF's new night-fighter squadrons to provide operational training in AI procedures, but by the end of the year almost all had disappeared from the service's front-line inventory.


AW392 was the first Havoc Mk I (Turbinlite), originally supplied to the RAF on a diverted French contract in 1940 and one of the early small-tail series with Twin Wasp engines. AI Mk IV radar was fitted to aim the searchlight, no guns being carried.

Specification
P-70A Havoc

Type: three-seat night-fighter
Powerplant: two 1,600-hp (1193-kW) Wright R-2600-11 14-cylinder air-cooled radial piston engines
Performance: maximum speed 529 km/h (329 mph) at 4265 m (14,000 ft); climb to 3660 m (12,000 ft) in 8 minutes; service ceiling 8610 m (28,250 ft); normal range 1706 km (1,060 miles)
Weights: empty 7272 kg (16,031 lb); maximum take-off 9645 kg (21,264 lb)
Dimensions: span 18.69 m (61 ft 4 in); length 14.50 m (47 ft 7 in); height 5.36 m (17 ft 7 in); wing area 43.11 m^2 (464 sq ft)
Armament: most aircraft (P-70A-2) had six 12.7-mm (0.5-in) machine-guns in nose and two others of the same calibre (hand-held) in rear cockpit

A very rare bird, the Douglas P-70B-1 was a 1943 rebuild of an A-20G attack bomber with AI Mk IV radar and forward-firing armament of six 'fifty-calibre' in packs at the sides of the fuselage. No ventral cannon were fitted.

The Helmore Turbinlite Experiment

At the height of the night Blitz Britain was anxious to develop efficient night fighting equipment and techniques. The Turbinlite experiment was intended to allow small, manoeuvrable single-engined fighters to operate effectively at night, their targets being illuminated by a powerful searchlight carried in the nose of a large radar-equipped night fighter. Ten Turbinlite squadrons were formed, but scored only one success.

Had the development of radar never taken place, the concept of illuminating hostile night raiders using powerful airborne searchlights would have been entirely logical, if not downright ingenious. As it was, AI radar was already in service and giving promising results when the extraordinary decision was taken by the RAF to go beyond the experimental stage and introduce the Helmore Turbinlite into service.

Originally conceived by Wing Commnder W. Helmore (a World War I veteran who had retired from the RAF between the wars) during the night *Blitz* of 1940-1, the Turbinlite was a powerful searchlight which, carried in the nose of a twin-engine AI-equipped fighter (codenamed the 'Satellite') whose radar would enable the pilot to fly towards the target before exposing the light, hopefully illuminating the enemy bomber which would then be shot down by an accompanying single-seat fighter (codenamed the 'Parasite').

Work started to convert a number of Douglas Havocs in February 1941 to accommodate AI IV and Turbinlites in the nose, and progressed at top speed. On 22 May 1941 No. 1451 (Turbinlite) Flight was formed at Hunsdon to work in collaboration with the Hawker Hurricanes of No. 3 (Fighter) Squadron, followed by Nos 1452-1460 Flights at West Malling, Wittering, Colerne, Tangmere, Honiley, Colerne, Middle Wallop, Hunsdon and Acklington respectively between July and December 1941; these units worked in conjunction with Nos 32, 87, 93, 247, 257, 264 and 486 Squadrons.

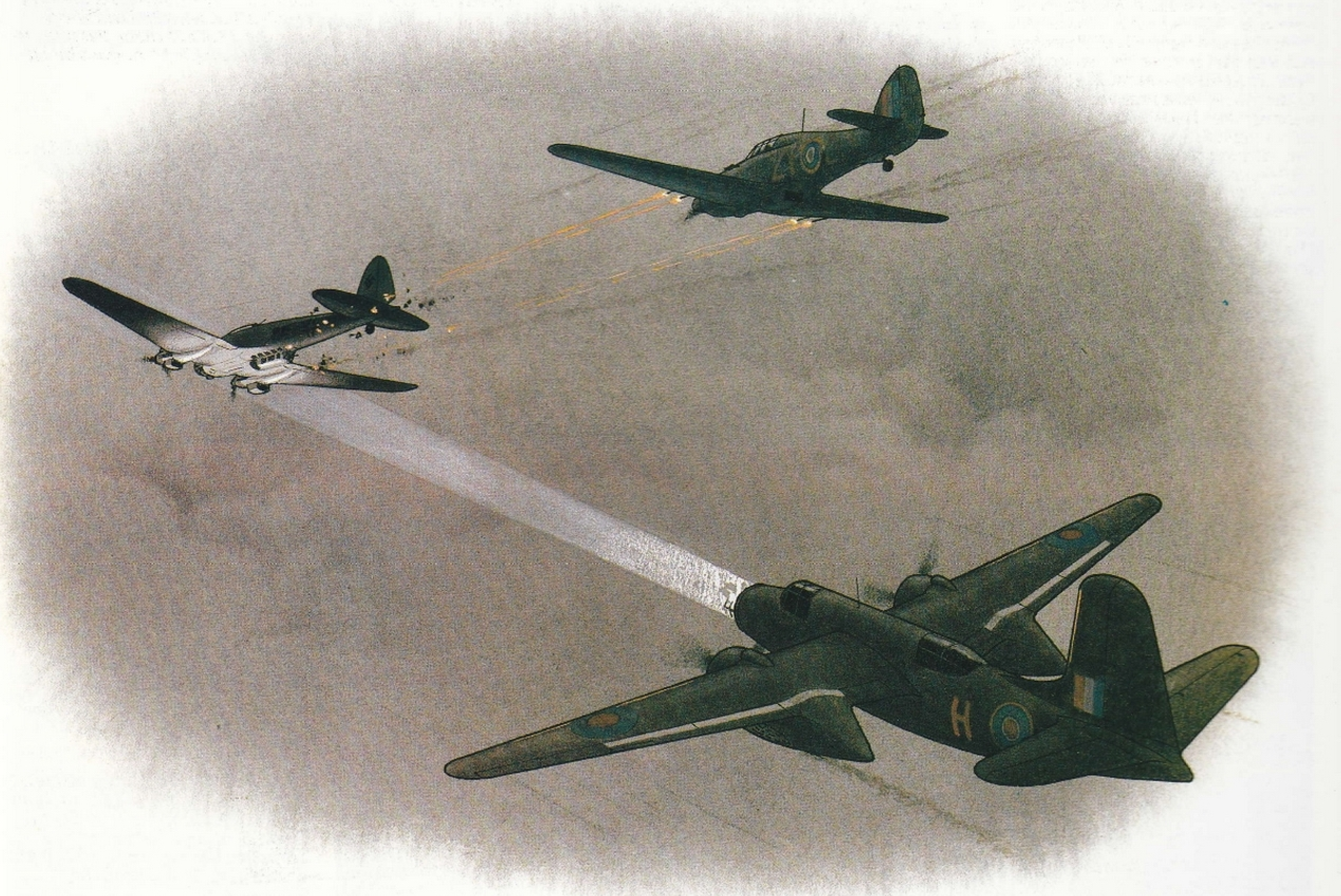
The interception procedure involved Satellite and Parasite taking off independently and forming up in close company (using formation lights), while instructions were passed by a ground controller to steer towards an approaching raider. At a range of about 6.4 km (4 miles) the Satellite's AI would hopefully enable it to close to within 460 m (500 yards) when the Turbinlite would be exposed. Once the target had been acquired on AI the codeword 'Boiling' was transmitted and the Parasite would lose 91 m (300 ft) in altitude, open up to full throttle and close to a range of 275 m (300 yards) from the target and open fire.

Parallel trials at the service test establishments had been described variously as 'disappointing', 'promising' and 'inconclusive' by Fighter Command and Air Ministry observers, the main objections being that the Turbinlite gave only a diffused illumination, and the fact that in cloud or bad weather the whole procedure was unworkable, not to mention the risks attendant on close formation flying at night. Moreover the Havoc itself was so slow as to be unable to catch most German raiders, and the Douglas Boston (also used) was little better; a de Havilland Mosquito was also tried, but this was not proceeded with.

Nonetheless the flights persisted in their operations. No. 1452 lost three aircraft in accidents (two when Satellite and Parasite collided); the Commander of No. 1453 flight made three separate 'Boiling' calls in one night, only to discover that his Parasite was not present; No. 1457 Flight illuminated a target and the Parasite opened fire only to discover that the victim was a Short Stirling. No. 1459 Flight was the only unit to achieve any success at all when, on 30 April 1942, Flight Lieutenant C.V. Winn in a Havoc Mk II illuminated a Heinkel He III which was then shot down by Flight Lieutenant Yapp of No. 253 Squadron in a Hurricane; this flight also probably destroyed a Dornier Do 217 and damaged another.

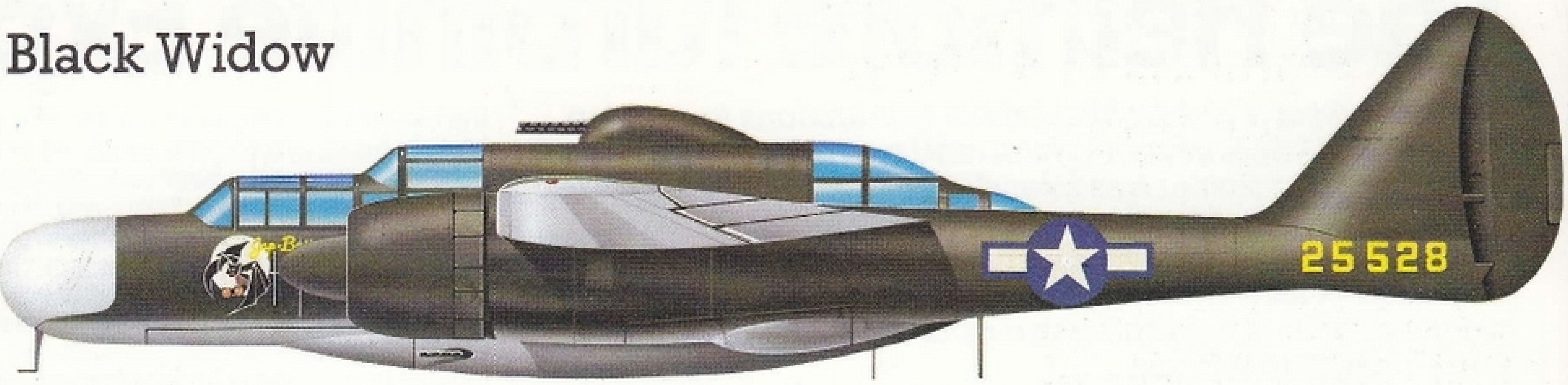
Fortified by these miniscule results, the RAF decided to expand the flights into full squadrons by absorbing one flight of Hurricanes from each of the 'Parasite' squadrons, and on 2 September 1942 Nos 1451-1460 Flights became Nos 530-539 Squadrons, between them fielding some 48 Havocs, 36 Bostons and about 60 Hurricane MK IIBs, MK IICs, MK Xs, Mk XIs, and Mk XIIs, staffed by more than 1,500 air and ground personnel. During the next 16 weeks these squadrons flew a total of fewer than 100 operational sorties and gained 11 contacts, but failed to fire on a single enemy aircraft. After 18 months of almost fruitless work the Turbinlite squadrons were finally disbanded on 25 January 1943. One is left to conjecture what impact all this effort, as well as that of the hard-worked ground radar controllers, would have had on German night raids if the resources had been channelled into 10 additional squadrons of conventional AI-equipped night-fighters.

This drawing shows the basic principle of the Turbinlite. In practice it was an unmitigated disaster, leavened only by the single victory illustrated, achieved by No. 1459 Flight. Posterity was to conclude that cannon shells made more sense than a searchlight beam.

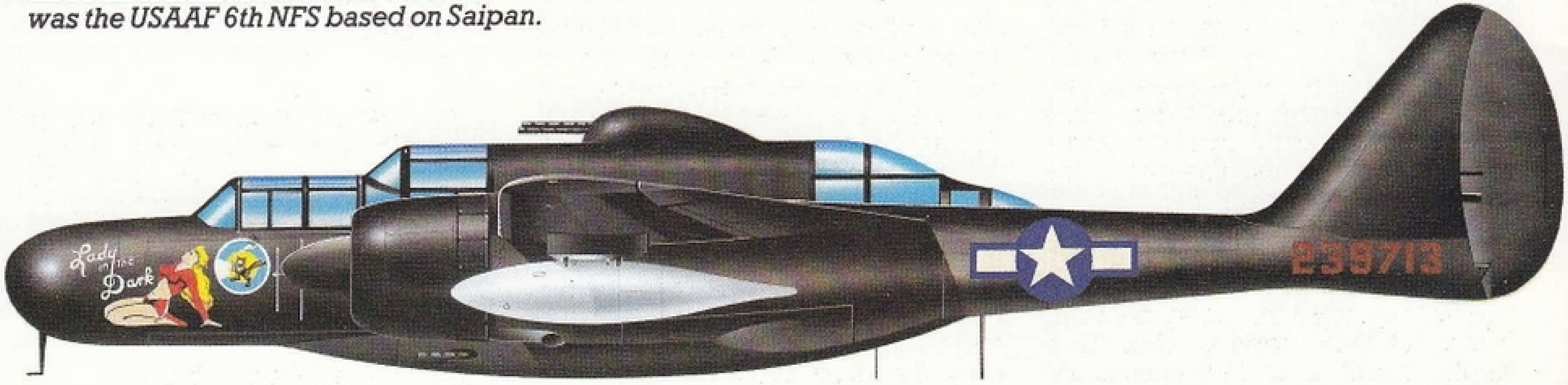


USA

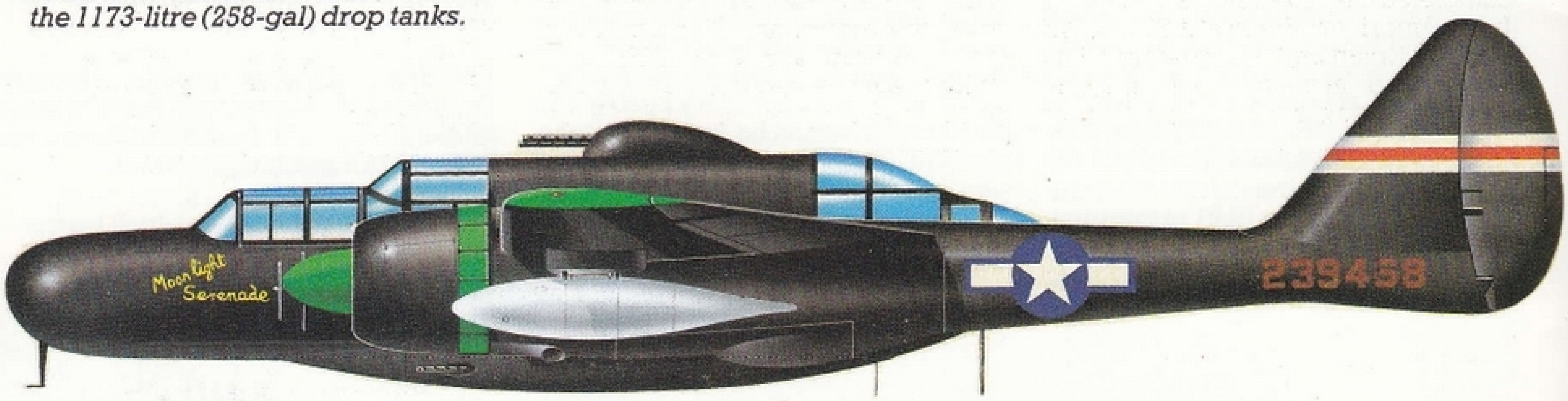
Northrop P-61 Black Widow



Unusual in having a completely unpainted radome over its SCR-720 radar, this early P-61A-1 was one of those delivered with the four-gun turret, and, like all three aircraft illustrated here went to the Pacific. In this case the recipient unit was the USAAF 6th NFS based on Saipan.



Almost all Widows were painted black overall, like this P-61B-15, one of the later models with the turret restored as standard. It was on the strength of one of the later units in the CPA (Central Pacific Area) in 1944, the 548th NFS. Note the 1173-litre (258-gal) drop tanks.



Almost identical to the machine above, this P-61B-1 was assigned to a unit of the US 13th Air Force, the 550th NFS operating in the New Guinea and New Britain area from Morotai in the final nine months of the Pacific war. The turret must have been fitted retroactively.

Stung to action in 1940 by events in Europe where night bombing attacks were beginning to assume significant proportions, the US Army Air Corps issued a general requirement for a specialized night-fighter, and to meet this Northrop offered a large twin-boom, twin-engine, three-seat aircraft with provision for yet-to-be developed airborne interception radar and a heavy offensive armament. Two Northrop XP-61 prototypes were ordered on 11 January 1941, and production contracts totalling 573 aircraft were issued within the next 13 months. The first prototype was flown on 21 May 1942, by which time the USA had been at war for nearly six months, and it was to be a further 18 months before the first production **P-61A Black Widow** aircraft appeared, the first 37 aircraft mounting a remotely-controlled dorsal turret with four 12.7-mm (0.5-in) guns in addition to four fixed 20-mm cannon in the fuselage belly. Air flow instability aft of the turret caused its deletion from the 38th aircraft onwards, and the first deliveries were made to the 18th Fighter Group of the USAAF, then based at Guadalcanal. This unit scored its first night victory on 7 July 1944, and the type progressively replaced all the interim Douglas P-70s in service.

The P-61A was not generally considered wholly satisfactory, being plagued by unserviceability of the big R-2800-65 engines; as the situation improved, after 200 of this version had been produced, deliveries of the first of 450 **P-61B** aircraft started, also in July 1944; this version, though still officially termed a night-fighter, was as much an intruder as a true fighter, being capable of carrying up to four 726-kg (1,600-lb) bombs or four 1136-litre (300-US gal) drop tanks under the wings. Some Far East units also carried out field modifications to carry eight 12.7 cm (5-in) rocket projectiles for night use against Japanese surface vessels, but their use was limited on account of the blinding flash of the rocket motors. The final 250 P-61Bs had the dorsal turret reinstated, and the last production version was the **P-61C**, of which 41 were built with 2,800-hp (2088kW) R-2800-73 engines and a top speed of fractionally under 644 km/h (400 mph).

In Europe the Black Widow was severely criticized when tested by the RAF, but deliveries of the first P-61As went ahead to the 422nd Night Fighter Squadron at Scorton, England, on 23 May 1944, followed by the 425th at Charmy Down, their purpose being to provide night protection for the American bases after the Normandy landing then imminent. While based in the UK the P-61s were flown with limited success against V-1 flying bombs before being flown to the Continent, where they achieved a few night victories against the relatively small number of German aircraft which operated at night during the last eight months of the war.

Specification

P-61B Black Widow

Type: three-seat night-fighter

Powerplant: two 2,000-hp (1491-kW) Pratt & Whitney R-2800-65 18-cylinder air-cooled radial piston engines

Performance: maximum speed 589 km/h (366 mph) at 6095 m (20,000 ft); climb to 6095 m (20,000 ft) in 12 minutes; service ceiling 10090 m (33,100 ft); maximum range 4506 km (2,800 miles)

Weights: empty 9979 kg (22,000 lb); maximum take-off 13472 kg (29700 lb)

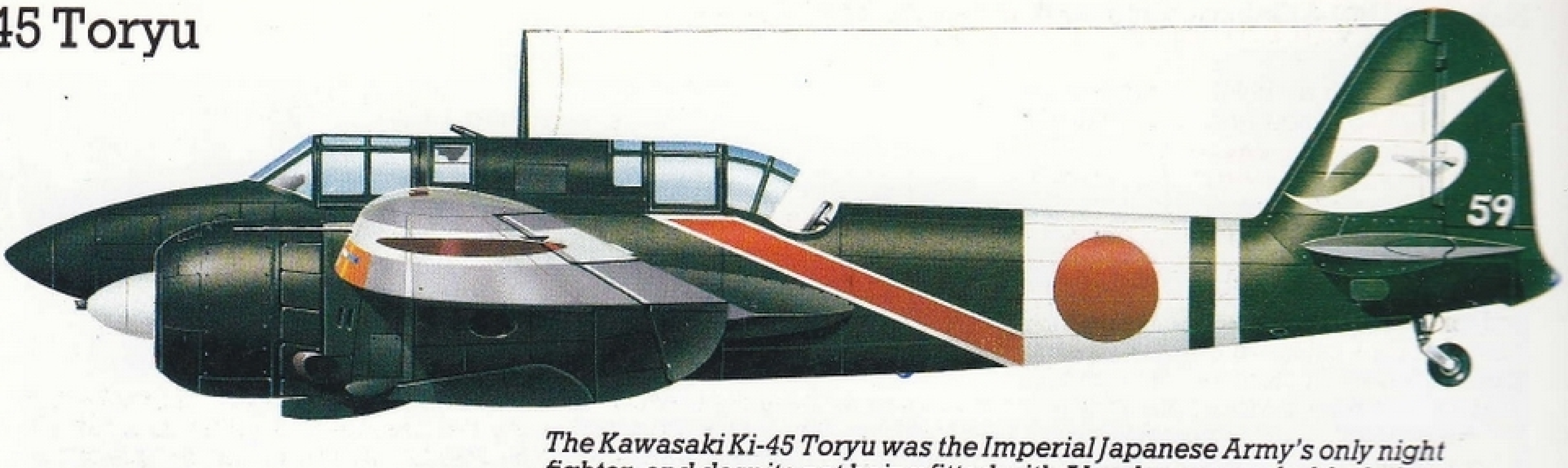
Dimensions: span 20.12 m (66 ft 0 in); length 15.11 m (49 ft 7 in); height 4.46 m (14 ft 8 in); wing area 61.69 m^2 (664 sq ft)

Armament: four 20-mm cannon in fuselage belly fixed to fire forward, plus provision to carry up to four 726-kg (1,600-lb) bombs under the wings; the last 250 aircraft were also armed with four 12.7-mm (0.5-in) machine-guns in remotely-controlled dorsal turret

One of the first P-61s to see action was this P-61A-10 of the 422nd Night Fighter Squadron based at Charmy Down, Scorton and then various advanced bases in France. Their kills were mainly flying bombs and locomotives.

JAPAN

Kawasaki Ki-45 Toryu



The Kawasaki Ki-45 Toryu was the Imperial Japanese Army's only night fighter, and despite not being fitted with AI radar was probably their most effective one.

Constant development frustrations delayed introduction into service of the Imperial Japanese Army's **Kawasaki Ki-45 Toryu** (dragon killer) until August 1942, its design having been initiated five years earlier, and it was not until 1944 that the night-fighter version, the **Ki-45 KAIc**, became operational as the only army night-fighter of the war. Retaining the two 1,080-hp (805-kW) Mitsubishi Ha-102 radials of the previous Ki-45 KAIb heavy day fighter (an aircraft whose role was akin to that of the German *Zerstörer*), the Ki-45 KAIc was armed with a single forward-firing semi-automatic 37-mm Type 98 cannon in a fairing under the fuselage, two oblique/upward-firing 20-mm Ho-5 cannon in the centre fuselage, and a single hand-held machine-gun in the rear cockpit. It had been intended to fit airborne radar in the nose, and therefore no nose guns were included; however, production difficulties seriously delayed this equipment and it did not enter service, although a single aircraft flew with centimetric radar shortly before the end of the war. Production of the Ki-45 KAIc got underway at Kawasaki's Akashi plant in March 1944, the first aircraft being completed the following month. On 15 June American Boeing B-29s of XX Bomber Command launched their first raid on the Japanese homeland, and were intercepted by eight Toryus whose pilots shot down eight of the big bombers. At that time about 40 Ki-45 KAIc fighters had been completed, and the aircraft went on to serve with the 4th Sentai at Usuki in the Oita prefecture, the 5th Sentai at Usuki and Komachi in the Aichi prefecture, the 53rd Sentai at Matsudo in the Chiba prefecture, and the 70th Sentai at Kashiwa. Toryus shared the night defence of Japan with the navy's J1N1-S and Yokosuka P1Y1-S, and were probably the most successful in action against the massive American raids in the last six months of the war; the 4th Sentai alone was credited with 150 kills, of which 26 were gained by one pilot, Captain Isamu Kashiide, all despite the lack of any AI radar. Away from the homeland Ki-45 KAIc night-fighters also served with the 45th Sentai in the Philippines and New Guinea late in 1944, and with the 71st Dokuritsu Hiko Chutai at Singapore in August 1945. Production of the Ki-45 KAIc reached 477 aircraft before being terminated in December 1944. The type was codenamed **'Nick'** by the Allies.

Specification

Ki-45 KAIC

Type: two-seat night-fighter

Powerplant: two 1,080-hp (805-kW) Mitsubishi Ha-102 14-cylinder air-cooled radial piston engines

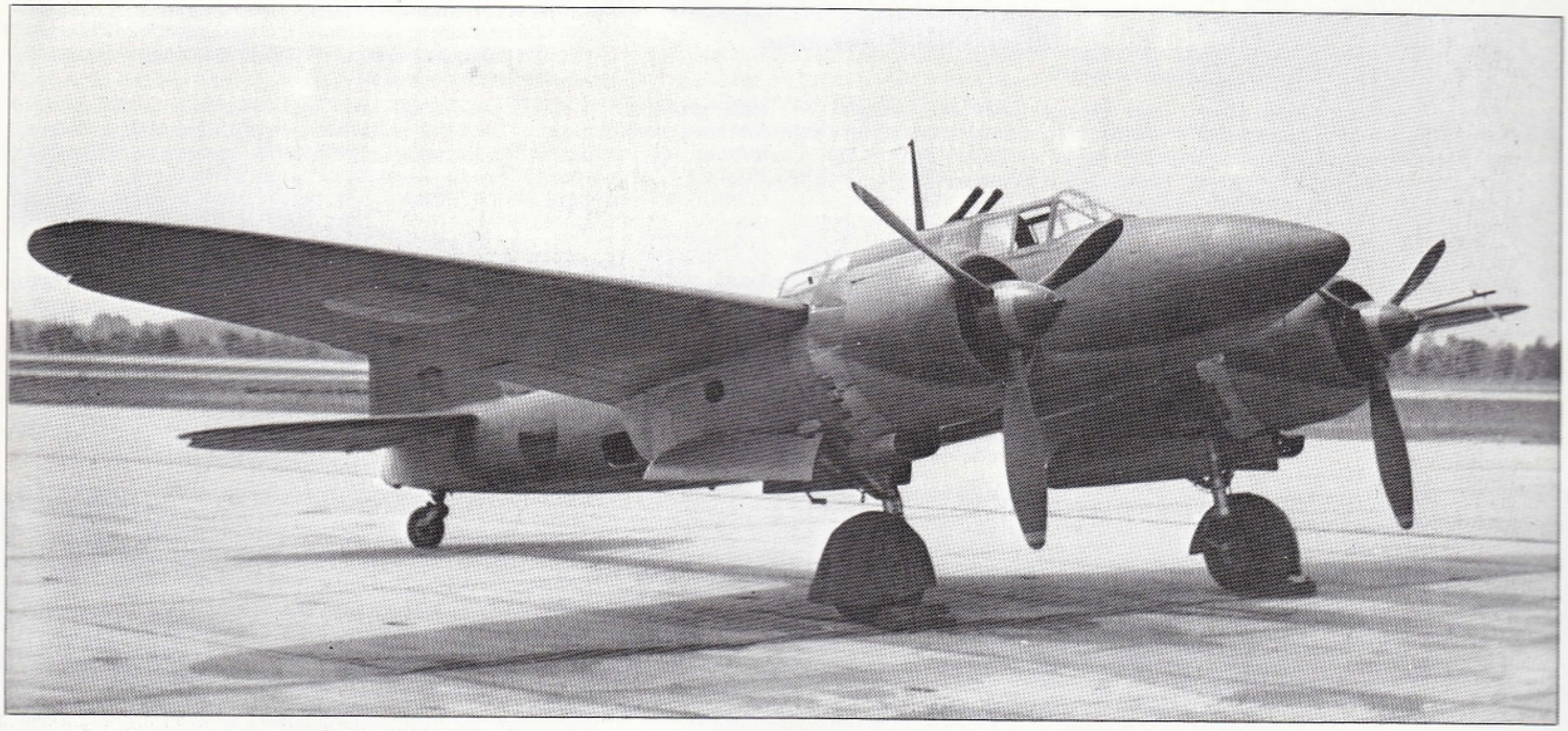
Performance: maximum speed 540 km/h (335 mph) at 6000 m (19,685 ft); climb to 5000 m (16,405 ft) in 7 minutes; service ceiling 10000 m (32,810 ft); normal range 2000 km (1,243 miles)

Weights: empty 4000 kg (8,818 lb); maximum take-off 5500 kg (12,125 lb)

Dimensions: span 15.02 m (49 ft 3¼ in); length 11.00 m (36 ft 1 in); height 3.70 m (12 ft 1¾ in); wing area 32.00 m² (344.44 sq ft)

Armament: one 37-mm cannon firing forward under nose, two upward-firing 20-mm cannon amidships and one 7.92-mm (0.31-in) hand-held machine-gun in dorsal position

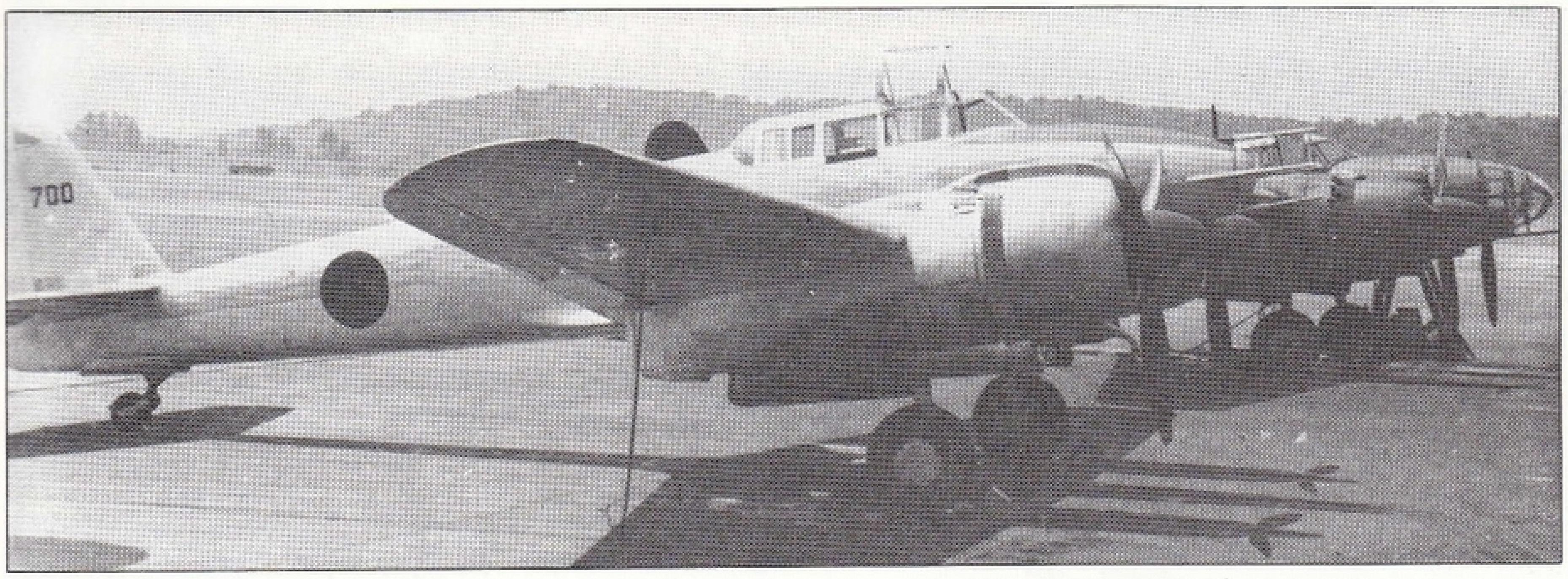
Probably the best surviving picture of a Kawasaki Ki-45, this Ki-45 KAIc night fighter has no radar but carries a 37-mm Ho-203 cannon firing ahead and two 20-mm Ho-5 cannon firing obliquely upwards. A total of 477 was built at Akashi in late 1944.



JAPAN

Nakajima J1N1-S Gekko

Just as specialist night-fighter design had largely been ignored by European nations before World War II, Japan's similar failing left the country without adequate night defence when the fortunes of war began their inexorable turn against her in 1943. Fortunately, however, the Imperial Japanese Navy possessed a number of excellent heavy fighters and reconnaissance aircraft, of which the **Nakajima J1N Gekko** (moonlight) had been arriving in service slowly since April 1942 with reconnaissance units in the Western Pacific. When first encountered in action during the Solomons campaign the aircraft was mistakenly thought to be a fighter and codenamed **'Irving'** by the Allies. As night air attacks were stepped up by the Americans it was the commanding officer of the 251st Kokutai, Commander Yasuna Kozono, then based at Rabaul, New Guinea, who first suggested adaptation of the J1N as a night-fighter by installing two 20-mm cannon in the observer's cockpit, fixed to fire obliquely forward and upward at an angle of 30°, and another pair firing forward and downward. When two Consolidated B-24s were quickly destroyed, the modifications came to the attention of the Japanese naval staff and an order was placed with Nakajima to go ahead with a dedicated night-fighter version, designed and built as such from scratch. This version, the **J1N1-S**, entered production in August 1943 and continued until December 1944, during which period a total of 420 J1Ns were produced, the great majority of them J1N1-S night-fighters. These differed from the earlier reconnaissance version in having the crew reduced from three to two, the observer's cockpit being eliminated and faired over; all aircraft retained the upward-firing cannon, but the downward firing guns (found difficult to aim and seldom used) were omitted from later aircraft, while a third upper gun and a forward-firing 20-mm cannon was fitted in the **J1N1-Sa**. Rudimentary centrimetric AI radar was installed in the nose and some aircraft also carried a small nose searchlight. In service with the 251st, 302nd and 322nd Kokutais, the J1N1-S night-fighters proved fairly effective against the B-24, which was not in any case well-suited to night operations, but with the appearance of the Boeing B-29 the Japanese night-fighters



Most J1N1-S night fighters were black, but this J1N1-Sa, with nose radar, was unpainted. In the rear is a P1Y1.

proved too slow and were seldom able to make more than a single firing attack. Most of them were expended during the final months of the war when, equipped to carry two 250-kg (551-lb) bombs, they were employed in *kamikaze* attacks against ground targets.

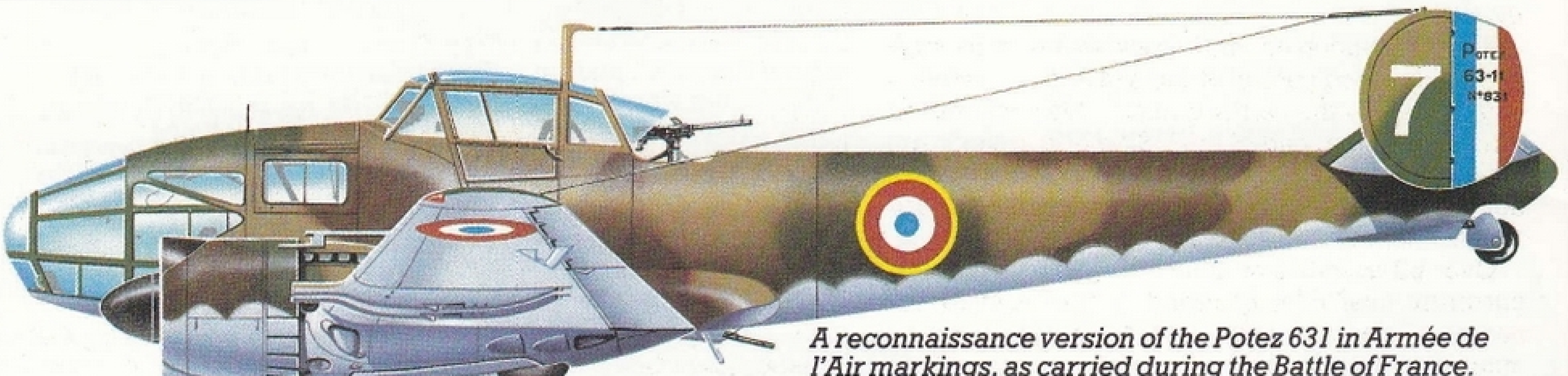
Specification

J1N1-S
Type: two-seat night-fighter
Powerplant: two 1,130-hp (843-kW) Nakajima NK1F Sakae 21 14-cylinder air-cooled radial piston engines
Performance: maximum speed 505 km/h (314 mph) at 5840 m (19,160 ft); climb to 5000 m (16,405 ft) in 9 minutes 36 seconds; service ceiling 9320 m (30,610 ft); normal range 2540 km (1,578 miles)
Weights: empty 4840 kg (10,670 lb); maximum take-off 8185 kg (18,045 lb)
Dimensions: span 16.98 m (55 ft 8½ in); length 12.77 m (41 ft 10¾ in); height 4.56 m (14 ft 11⅔ in); wing area 40.00 m^2 (430.56 sq ft)
Armament: two (sometimes three) upward-firing 20-mm Type 99 cannon, two downward-firing 20-mm cannon and (optional) one forward-firing 20-mm cannon

---

FRANCE

Potez 631



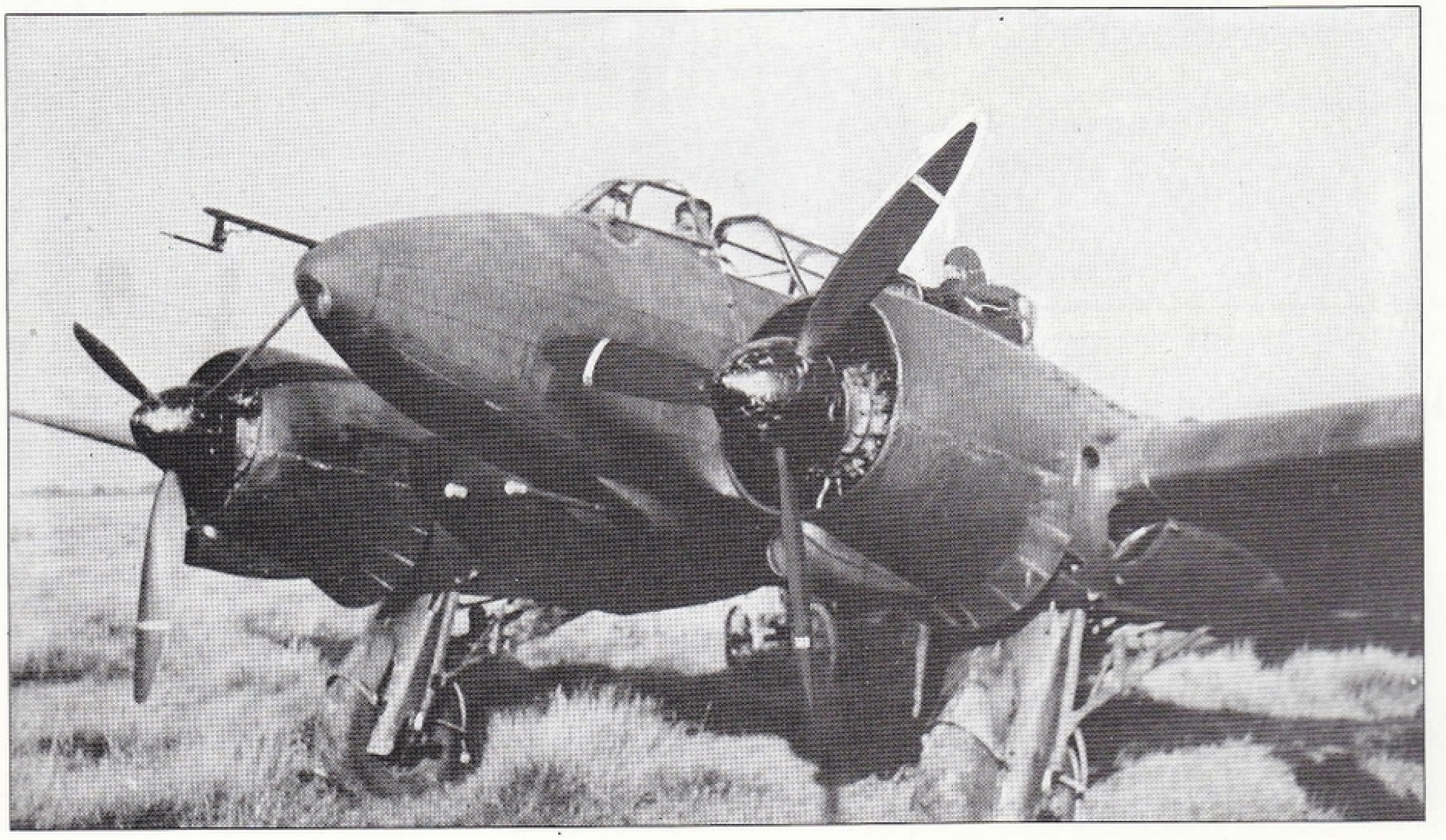
A reconnaissance version of the Potez 631 in Armée de l'Air markings, as carried during the Battle of France. The type's similarity to the Bf 110 led to heavy losses at the hands of the Allies.

The French **Potez 631** night-fighter corresponded in many respects to the RAF's Bristol Blenheim, being very similar in size and performance (though somewhat lighter) as well as being conceived as a variation of a light bomber. The French aircraft was one of a family of design variations of the Potez 63 which had originated in a requirement issued in 1934 for a two/three-seat 'multi-purpose' aircraft. Although a night-fighter prototype had flown in March 1937 as the **Potez 631-0**, French re-equipment policies were blurred by lack of purpose (being confused by the likely form of warfare being studied by Germany), with the result that orders for development aircraft included four-general purpose two/three-seat day/night fighters, three two-seat night-fighters, one light bomber, one reconnaissance aircraft and one close-support aircraft. Relatively little importance was placed on the Potez 631 night-fighter, and it was not until June 1938 that production orders totalling 207 were confirmed.

By 1 April 1939 the Armée de l'Air had taken delivery of 88 aircraft, of which 20 were in service; in May two night-fighter units, Groupes de Chasse de Nuit GCN III/1 and II/4, and one day fighter unit, GC II/8, were equipped with about 30 aircraft; four other Potez 631s were serving at Djibouti. At the outbreak of war a total of 206 aircraft had been delivered, and the type had also joined GCN I/13 and GCN II/13, as well as seven *escadres de chasse*. Some aircraft were later transferred to the Aéronavale. When the German attack opened in the West the various Potez 631 units were in constant action both by day and night, although lack of radar prevented much success during the hours of darkness. In the first 11 days of the campaign Aéronavale's Flotille F1C shot down 12 German aircraft for the loss of eight, but the Armée de l'Air night-fighter units were ordered to assume day ground-attack duties, losing heavily to enemy flak. Moreover, losses were exceptionally heavy to Allied guns and fighters as a result of the Potez 631's superficial similarity to the German Messerschmitt Bf 110; it has been estimated that as many as 30 of the French aircraft were shot down in error. In all, Potez 631 night-fighters destroyed a total of 29 German aircraft in the Battle of France, but for a loss of 93 of their own number. Of the remainder about 110 were in the Free French Zone (Vichy France) at the time of the armistice, but their number dwindled quickly because of a chronic lack of spares, although ECN 3/13 moved to Tunisia with a small number of Potez 631s in June 1941.

Specification

Potez 631
Type: two-seat night-fighter
Powerplant: two 700-hp (522-kW) Gnome-Rhône 14 air-cooled radial piston engines
Performance: maximum speed 442 km/h (275 mph) at 4500 m (14,765 ft); climb to 4000 m (13,125 ft) in 5 minutes 54 seconds; service ceiling 8800 m (28,870 ft); range 1220 km (758 miles)
Weights: empty about 2450 kg (5,401 lb); maximum take-off about 3760 kg (8,289 lb)
Dimensions: span 16.00 m (52 ft 6 in); length 11.07 m (36 ft 4 in); height 3.62 m (11 ft 10½ in); wing area 32.70 m^2 (351.98 sq ft)
Armament: two fixed forward-firing 20-mm cannon under fuselage and one hand-held 7.5-mm (0.295-in) machine-gun in dorsal position; some aircraft were also fitted with two 7.5-mm (0.295-in) machine-guns under each wing



Though over 300 Potez 631 night fighters had been delivered at the time of the French Armistice on 25 June 1940, at least 70 and possibly many more either had no propellers or had them removed deliberately. This one was luckier, and flew with a unit of GCN 13 in the Battle for France.

US Navy

Part 4

Amphibious forces

To generalize, it can be said that the carrier groups are in the business of 'sea control' and submarine forces in that of 'sea denial'. The third vital aspect of sea power is 'power projection', much of which is provided by the US Navy's amphibious warfare ships.

Control of the sea is a rather abstract concept, but land can be occupied. The agency for this is the US Marine Corps and the US Army, and the means of their delivery 'over the beach' is vital to extend the list of options open to a commander. Amphibious landings can outflank defences and natural obstacles; the permanent threat of such an operation produces uncertainty in the mind of the enemy and causes him to dissipate his limited strength to cover eventualities.

The island-hopping Pacific war was won by such operations once control of the sea and air had been established by the carrier groups. This combination remains a potent part of the US Navy inventory, and is respected by the Soviets to the extent that production of an effective antidote greatly influenced the development of their own fleet.

Over 60 assorted amphibious warfare ships are currently available, grouped in the inelegantly-named 'Phibrons', each capable of remaining on station with a reinforced marine battalions and its full equipment. At least one Phibron is usually attached to each of the major fleets. Since the end of World War II a minimum of 20 kts sustained sea speed is required of each ship, and this has combined with a need to operate worldwide to produce ever larger and more expensive ships, a tendency accelerated by the trend to combine the functions of the earlier attack cargo ships and transports with amphibious requirements. The ships no longer beach themselves, having embarked landing craft stowed aft in floodable wells.

The 27 amphibious transport docks (LPDs) and dock landing ships (LSDs) are closely related, in essence each being a self-propelled floating dock. The former type has the emphasis on troop accommodation and the latter on larger docking facilities. Building currently is the 'Whidbey Island' (LSD 41) class, which is little changed except for the adoption of diesel machinery and a dock configured for stowage of air cushion landing craft (flexible-skirted hovercraft).

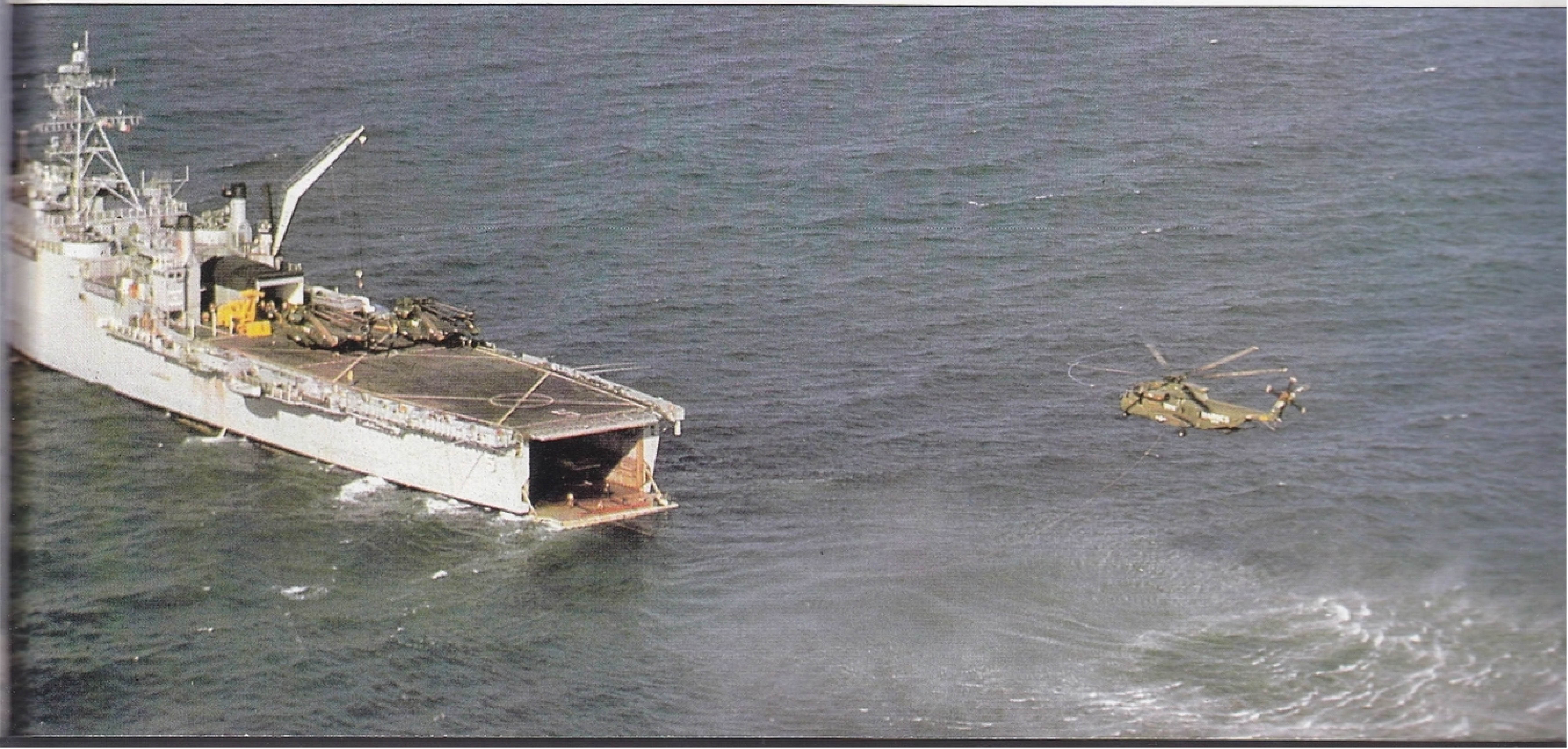
Docked ships are essentially second-wave assets, consolidating the beach-heads seized by shock landings of spearhead groups. These arrive without warning in large helicopters, such as the Boeing Vertol CH-46 Sea Knight or the Sikorsky CH-53 Sea Stallion, operating from amphibious assault ships such as the 'Iwo Jima' class LPHs or the 'Tarawa' class LHAs.

The LPHs are like small carriers, lacking fixed-wing facilities but carrying 1,750 combat troops, their gear, vehicles and artillery, together with 20 large helicopters for their transport.

Doubling the LPHs' displacement at nearly 40,000 tons are the LHAs which, though no doubt highly efficient, have adopted an all-eggs-in-one-basket approach. The consequences of losing such a ship fully loaded must weigh heavily on the mind of its commanding officer.

The various requirements of amphibious warfare stimulates the spawning of an infinite number of variants, and planned for the late 1980s is the so-called amphibious assault dock (LHD), which promises to be as large as a 'Tarawa' but closer to an 'Iwo Jima' in concept.

Boeing Vertol CH-46 helicopters are prepared aboard an American LHA off Grenada. The first stage of an American assault consists of heliborne Marines making a 'vertical envelopment'.



A Marine Corps Sikorsky RH-53 assault helicopter approaches the helicopter deck of USS Ogdon (LPD 5). The amphibious transport dock has its well open, but not flooded down.

Armed Forces of the World

The ammunition ship USS Flint *(AE 32) as seen by USS* Chicago *during a replenishment operation.* Flint *can also provide vertical replenishment using its two UH-46 Sea Knight helicopters.*

Keeping a close and integrated control over a large landing is not easy, and requires the commanders of each service (together with their staffs) to be sited together. Communications are vital and, although larger ships such as LGAs have a degree of capability as command ships, specialist ships are superior. All such war-build units have now been discarded, leaving only the two 'Blue Ridge' class LCCs.

An almost universal shortcoming among American amphibious warfare ships is an armament inadequate to meet a threat from modern weapons. They are utterly dependent upon their escort for protection and, with the more-capable cruisers and destroyer committed largely to the battle group, the US Navy's frigates will be given the task, additional to ASW and commerce protection.

Fleet support

A great strength of the US Navy has always been its fleet support, the train of auxiliaries that works with a battle group for its replenishment, or acts as forward bases for destroyers and submarines. The force was developed early as the US Navy never enjoyed the benefits of a worldwide chain of bases yet needed support for out-of-area deployments. Accompanying the fleet are the big 20-kt replenishment oilers (AOR), ammunition ships (AEs) and fast combat support ships (AOEs). These are able to undertake underway replenishment from alongside (UNREP) or by large helicopter (VERTREP), and carry a vast range of dry stores, ordnance and fuels. They are highly valuable ships and need defending in their own right.

For a time it was American policy increasingly to negotiate forward base rights on foreign soils but, as this became politically less acceptable, further destroyer and submarine tenders (ADs and ASs) have been constructed. These can service destroyers and cruisers, up to six at a time, whether gas turbine-, steam- or nuclear-propelled, their crews' expertise including the repair of all types of weapons systems and electronics. Similarly, the AS can handle up to four SSNs and SSBNs simultaneously.

Transportation of the vast quantities of dry materials and oil needed worldwide by the fleet is the province of the Military Sealift Command, which covers also duties such as oceanographic research and missile down-range instrumentation ships. A more recent responsbility is the provision of ships for the controversial Rapid Deployment Joint Task Force currently Indian Ocean-based.

This force is building rapidly, benefiting from the ready availability of high-class mercantile tonnage at prices artificially low as a result of the recession. When up to strength, the RDJTF will be able to support for a month three reinforced and mechanized Marine Amphibious Brigades, wherever they should be required.

Finally, but not to be overlooked, is the US Coast Guard, which, though normally administered by the Department of Transportation, is a branch of the armed services. Its cutters are becoming ever more closely akin to escorts, the high-endurance vessels having CODOG propulsion, fire control, sonar and an embarked helicopter. In times of emergency, the USCG comes directly under naval control.

With the Soviet fleet bent on continuous expansion, the USN has a ready target to match, its task made no easier as the current British obsession with nuclear weapons inevitably reduces its expenditure on conventional armaments, including its still-valid surface fleet.

USS Sylvania *(AFS 2), a 'Mars' class combat store ship, has five holds (one refrigerated) to carry its 4,000 tons of supplies. Here helicopters line up to assist in the transfer of stores.*

12 PASS